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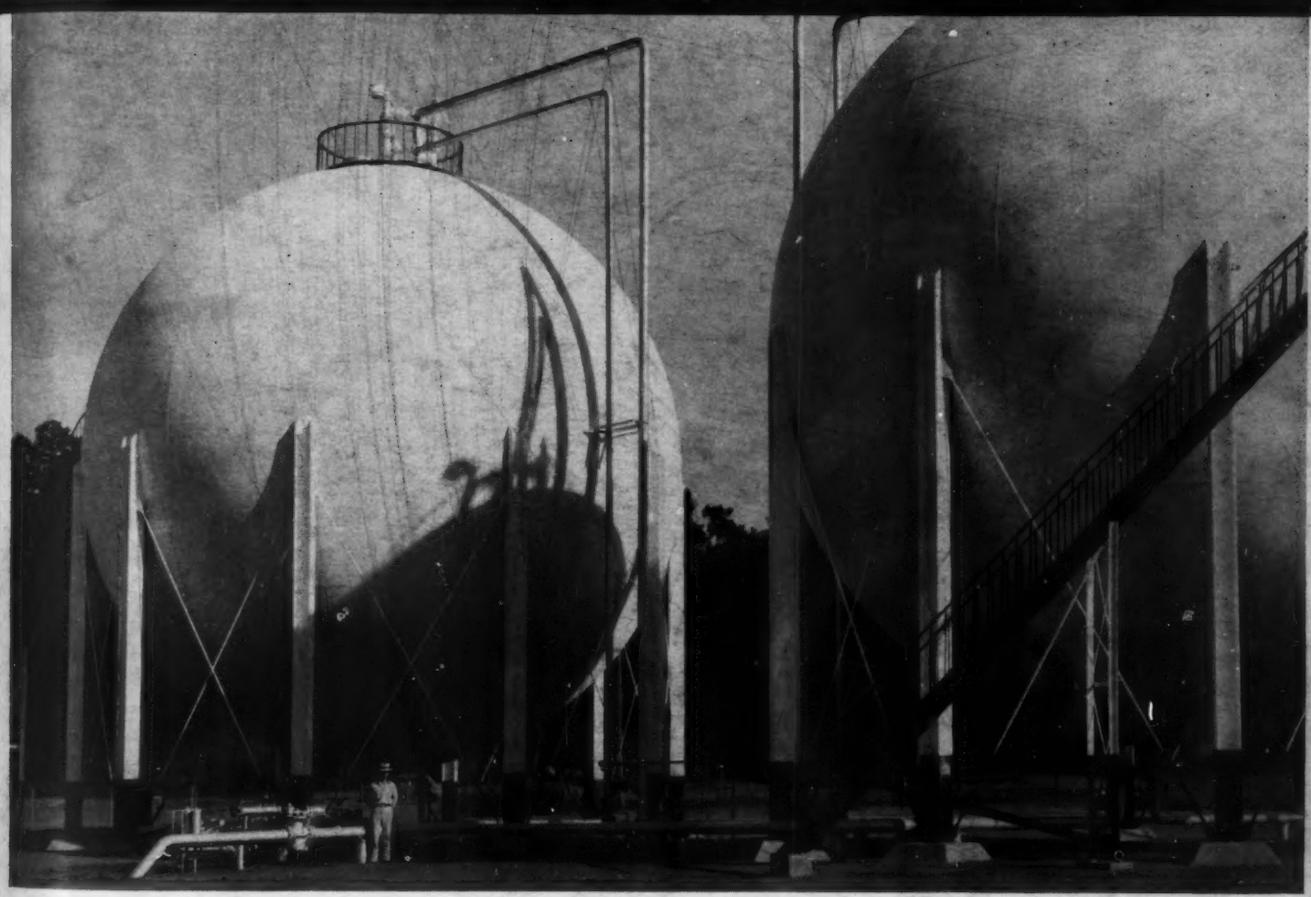

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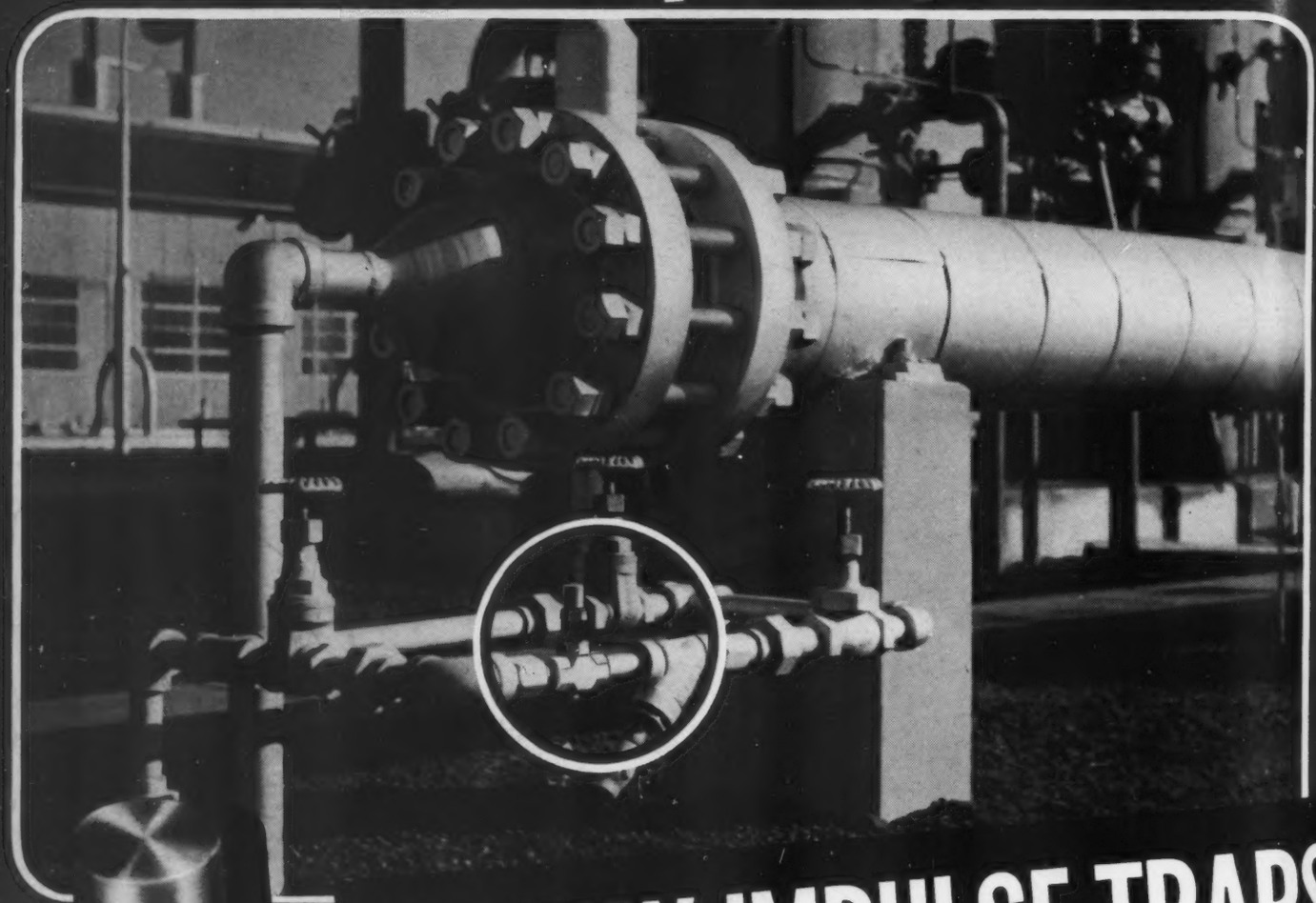

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# PETROLEUM REFINER

SPECIALIZED FOR THE OIL REFINING INDUSTRY, INCLUDING PETRO-CHEMICAL ENGINEERING, PETROLEUM SYNTHETICS AND NATURAL GASOLINE

APRIL, 1943
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GRADY TRIPLETT
*Editor*



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There Can't Be
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MASONEILAN

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PETROLEUM
REFINER

SPECIALIZED FOR THE OIL REFINING INDUSTRY, INCLUDING PETRO-CHEMICAL ENGINEERING, PETROLEUM SYNTHETICS AND NATURAL GASOLINE

A GULF PUBLISHING COMPANY PUBLICATION

# THE LOOK BOX

SOMEHOW absenteeism seems too foreign and so far away. It pertains to shipyards, airplane factories and tank manufacturing, where men are drawing high wages, working overtime, a set of conditions so desirable that men become careless and fail to stay on the job.

**What Is So Different?**

Nothing like that happens in a refining plant! Besides a refining plant is different from a shipyard. In a shipyard men are making tankers and in a refinery . . .

From Washington comes this indefinite estimate: that some days the Allied planes in North Africa use more than a million gallons of 100-octane aviation gasoline. How much more than a million gallons is a military secret as it is how often the consumption is reached.

Then it becomes evident that staying on the job is as vital in a refinery as in an airplane factory. Where would one be without the other? Absence from the one is as serious and as unpatriotic as the other.

One of the nurses, fortunately rescued from Corregidor, recently told of standing by while the wounded would ask the surgeon, "what chance have I got?" Even when the chance was hopeless the surgeon would strive to be reassuring.

Seldom could the victim be deceived and time after time this nurse had heard men give orders to be removed from the operating table so the hospital staff could give its time and skill where there was hope.

When men rank the refining plant or the tank plant with the battle front, their words are empty. Neither offers anything to compare with the heroics of the man, who, knowing death to be certain, asks to be put aside so others may live. The production front simply is not of that order.

Absenteeism is not the proper word for describing the crime of being away from a job whose output may prevent men from making such decisions in a desert hospital. Men who fail to give all on the home front are slackers and cowards, and that goes for refining plants as well as plants where tanks and airplanes are made.

An additional hundred gallons of gasoline or lubricating oil may bring some men home from the flak areas or it may permit others to go out and destroy the dive bombers which harass the ground troops.

Absenteeism does not exist on the desert or in the jungle.

PERHAPS the bill drawn by Senator Harley M. Kilgore of West Virginia will never reach committee stage. If it does chemists and engineers should sharpen their pencils and prepare to demand a word. The statesman from West Virginia would put science and invention inside of a bureaucratic strait jacket. It would create "The Office of Scientific and Technical Mobilization."

**Scientific Mobilization**

After reciting the lack of coordinated knowledge of scientific and technical knowledge, "the consequent delay and ineffectiveness in meeting the urgent scientific and technical problems of the national defense and civilian needs," it would set up a bureau for directing the laboratories and

research organizations of the nation in proper channels.

Perhaps the senator does not subscribe to a newspaper or own a radio. Through either of these he could have learned long ago that scientific development was and has been far ahead of government or finance in providing for national defense.

Aviation-grade gasoline was a fact and not a laboratory possibility well ahead of any need for it. Synthetic rubber was being made when Singapore fell. These are but two instances within the petroleum industry. Other industries can cite scientific advance equally as convincing.

Still a senator would turn to the government for scientific leadership. It was the government which rejected a program for providing capacity of 100,000 tons of synthetic rubber back in 1940. Scientists proposed it.

In that instance wisdom was with science which was not under obligation to the government.

Science will continue to be prepared only when it can advance without the restrictions of a federal director.

**Pay Load**

COLD logic removes some of the attractiveness from the promise of the huge cargo plane. That the airplane can circle the globe is true. How much pay load it carries depends on how often it can take on motor fuel.

The problem is clear in this paragraph from an article in *The Lamp*, reproduced elsewhere in this issue:

"If one of the mammoth cargo planes we have been hearing about were to lift its 250,000 pounds over San Francisco tomorrow, and, with its six engines beating steadily, head for Australia with enough fuel for the 16,000-mile round trip, the quantity of military supplies it could carry would be exactly nothing."

All its cargo space would be required for gasoline. Numerous fueling stations are the answer to more pay load in the air. And fueling stations depend on the tanker.

It seems that going into the air to defeat the submarine has limitations.

**Thirty To One**

IN THE making of rubber by synthesis, 10,000 men in chemical processing will accomplish what 300,000 coolies formerly did in the Far East. This is part of the prospect facing the new industry as presented by Dr. Robert V. Yohe, of The B. F. Goodrich Company, to the Society of Automotive Engineers.

"At least 500 highly trained chemists and chemical engineers will be required," he added, "and twice that number of highly skilled craftsmen must be made available. Many others must be given intensive training."

These manpower requirements are based on the making of 900,000 tons of rubber in a year. Magnitude of the task will call for enough soap every day to make "a soap track 25 miles long if made into ordinary laundry-size bars. To season the gigantic mix of butadiene-styrene-sodium (soap), a daily requirement of 500,000 pounds of common salt will be required."

What the several industries compound each day will fill a tank car train 25 miles long.

As for technical progress, Dr. Yohe explained, whereas at the outset—"The prime objective of all of us was that of just making synthetic rubber, we have already progressed so that the rubber is assured and the prime objective now has become the attainment of a uniformly high quality."

**Scouting For It**

BOILERS from an electric light plant in New England are being installed in one of the butadiene plants along the Gulf Coast. Doubtless the Middle West has contributed to the expansion program on the Pacific Coast. The ramifications by which idle equipment has been shunted into active duty in the butadiene program is one of its bright spots. If construction engineers had waited for priorities and directives to assure equipment, finished synthetic rubber would have been delayed far longer than the present promise.

Material scouts simply took to the industry trails and uncovered what the new plants demanded. How this was done has been told in "Our Sun," publication of the Sun Oil Company, whose Toledo butadiene unit brought on a search for equipment:

"Search for the second-hand equipment wrote an unusual chapter in Sun annals. From the East Coast to Arizona from Michigan to Texas, material scouts fine-combed likely areas for needed items that could be bought.

"One bountiful source was a large assemblage of pre-war refinery equipment destined for overseas before fighting began and since held at East Coast docks and warehouses. Sun scouts arranged for the purchase of most of it for conversion into fractionators, heat exchangers, gas coolers, etc.

"From a copper mine in Arizona came a blower; from ice-cream plants in Philadelphia, New York and Chicago came compressors, motors, condensers, accessories for the new plant's refrigeration unit. These scouts located boilers, stacks, fans and pumps at a Tennessee chemical plant. Boston yielded blowers and Oklahoma parted with absorbers. From Delaware came large pumps and motors for the plant's water-circulation system."

"The unique search covered 40 of the 48 states."

# Petroleum as a Source of the Aromatic Hydrocarbons

A. W. TRUSTY, Chief Chemist, Arkansas Fuel Oil Company

THE production of benzene, toluene, and other aromatic hydrocarbons from the distillation of coal formerly yielded a volume sufficient for normal peacetime consumption. The unprecedented wartime demand has made it necessary to look for other sources for these vital materials. The demand for aromatics for the manufacture of synthetics in such varied fields as rubber, perfume, medicine, and plastics is continually increasing. The motor fuel for the post-war high-compression engine will contain more aromatics than in the past. It is predicted that large-scale production of aromatics will continue after the war. The production and properties of the aromatic hydrocarbons are herewith discussed.

### Production from Coal

When coal is distilled, a variety of gaseous, liquid, and viscous tarry products are expelled. A solid residue of coke remains in the retort. The coal gas is separated from the liquids and tars by means of condensers, and after being freed from ammonia and hydrogen sulfide by scrubbing with water and other chemicals it is conveyed to commercial gas mains. A typical gas analysis is

| | |
|---|---|
| Hydrogen | 45-50 percent |
| Methane | 30-40 percent |
| Carbon monoxide | 6-10 percent |

and small quantities of carbon dioxide, nitrogen, acetylene, benzene, and ethylene.

The liquid distillate separates into two layers. The upper layer consists of an aqueous solution of ammonia, ammonium carbonate, ammonium hydrosul-

**Physical Properties of Some Aromatic Hydrocarbons**

| HYDROCARBON | Formula | Boiling Point ° F. | Melting Point ° F. | A.P.I. Gravity |
|---|---|---|---|---|
| Benzene (Benzol) | $C_6H_6$ | 176 | 43 | 28.9 |
| Toluene (Methyl Benzene) | $C_6H_5CH_3$ | 232 | —139 | 31.3 |
| O-xylene (1-2 Dimethyl Benzene) | $C_6H_4(CH_3)_2$ | 288 | — 16 | 28.2 |
| M-xylene (1-3 Dimethyl Benzene) | $C_6H_4(CH_3)_2$ | 283 | — 65 | 29.1 |
| P-xylene (1-4 Dimethyl Benzene) | $C_6H_4(CH_3)_2$ | 280 | — 58 | 29.3 |
| Ethyl Benzene | $C_6H_5C_2H_5$ | 278 | —137 | 28.8 |
| N-propyl Benzene | $C_6H_5.CH_2.CH_2.CH_3$ | 318 | ..... | 32.1 |
| Iso-propyl Benzene (Cumene) | $C_6H_5.CH(CH_3)_2$ | 306 | —143 | 31.7 |
| Naphthalene | $C_{10}H_8$ | 424 | 176 | sp. gr. 1.145 |
| Anthracene | $C_{14}H_{10}$ | 670 | 423 | 1.25 |
| Styrene | $C_6H_5.CH:CH_2$ | 295 | — 26 | 24.0 |

fide, pyridine, and some other compounds. The lower layer consists of a heavy, dark, oily mass known as coal tar. A partial separation of the tar is made by fractional distillation:

1. The light oil, benzene, toluene, xylene, some pyridine and naphthalene; it forms 25 percent of the total, and boils up to 338° F.

2. The carbolic oil, phenol, naphthalene and pyridine bases; it forms 10 percent of the total and boils up to 437° F.

3. The creosote oil, mainly cresols; it forms 10 percent of the total and boils up to 518° F.

4. The heavy oil, anthracene, phenanthrene, carbozol, forming 40 percent of the total and boiling up to 608° F.

The purification of these fractions is made by distillation, caustic treatment, and sulfuric-acid washing. The light oil is redistilled under reduced pressure; the overhead fractions are treated with sulfuric acid, neutralized with caustic soda and redistilled in steam, atmospheric stills. The yield per ton of original coal is

Benzene .....2.0 gallons
Toluene ..... .4 gallons
Xylene ..... .2 gallons

The production of coal tar products in 1940 was as follows:

Benzene and motor benzene.....137,000,000 gallons
Toluene ..... 30,000,000 gallons
Xylene ..... 5,600,000 gallons
Naphthalene .....159,000,000 gallons

The average yield of products per ton of coal is

10,500 cubic feet of gas
1450 pounds of coke
10 gallons of tar
22 pounds of ammonium sulfate
2.7 gallons of motor spirits.

### Occurrence in Petroleum

Scarcely any aromatic hydrocarbons are found in natural gases. Small amounts begin to appear in the lighter liquid fractions from crude oils, and the aromatic content of the heavier fractions of a naphthenic-base crude oil increases in volume considerably. Rarely can a crude oil be found with sufficient aromatics present to justify commercial separation. For the production of aromatics from petroleum sources, it is necessary to use some thermal- or catalytic-cracking process.

The most thorough investigation of the hydrocarbon constituents of a crude oil probably was the work done by the Bureau of Mines[1] in A.P.I. Project No. 6. The amount of aromatic hydrocarbons present in Oklahoma crude oil is shown:

Benzene ..... .08 percent by volume
Toluene ..... .30 percent by volume
p-xylene ..... .04 percent by volume
O-xylene ..... .12 percent by volume
m-xylene ..... .12 percent by volume
Ethyl benzene ..... .03 percent by volume

Bureau of Mines preliminary work on East Texas naphtha showed the following aromatic content:

Benzene ..... .04 percent by volume
Toluene ..... .46 percent by volume
Ethylbenzene ..... .14 percent by volume
n-propyl benzene ..... .04 percent by volume
Xylenes ..... .56 percent by volume

Canadian workers have investigated the aromatic content of two Canadian crude oils.

| | Foundation Well No. 1 Turner Valley | Sterling Pacific No. 3 Turner Valley |
|---|---|---|
| Benzene | .28 | .32 |
| Toluene | 1.07 | 2.00 |
| Xylene and Ethyl Benzene | 1.45 | 2.50 |

Garner and Evans[2] have determined the aromatic content of gasolines from crudes from various parts of the world:

| CRUDE OIL | Yield of Gasoline | Benzene | Toluene | Xylene | Total Aromatics Up to 302 F. |
|---|---|---|---|---|---|
| Seminole, Okla. | 36 | .1 | .6 | 1.5 | 2.2 |
| Grosny, Russia | 13 | .4 | 1.4 | 2.0 | 3.8 |
| Mexican | 10 | .5 | 1.5 | 3.0 | 5.0 |
| Panuco | 3 | .7 | 1.9 | 4.0 | 6.6 |
| Venezuelan | 7 | .9 | 1.5 | 3.7 | 6.1 |
| Colombian | 20 | .2 | .8 | 1.3 | 2.3 |
| California | 20 | .6 | 2.4 | 3.7 | 6.7 |
| Persian | 30 | 1.5 | 4.5 | 5.1 | 11.1 |
| Heavy Smackover, Ark. | .. | .15 | .4 | 1.5 | 2.05 |
| Roumanian | .. | 1.8 | 3.6 | 4.2 | 9.6 |
| Borneo | .. | 7.0 | 14.0 | 15.0 | 36.0 |

### Production of Aromatics from Petroleum

The yield of aromatics from straight-run petroleum fractions is so small that this source is impractical for commercial utilization. It is necessary, therefore, to use some thermal, or thermal-catalytic process to bring about the conversion of aromatics from one of the three other hydrocarbon groups—paraffins, unsaturates, or naphthenes. Dehydrogenation of the naphthenes, dehydrogenation and cyclization of the paraffins, and polymerization of the unsaturates are the usual reactions used. A review of the yields and conditions for aromatic production from some petroleum stocks is shown:

### Methane

The decomposition products of methane at 1832° F. are

Benzene aromatics .....3.2 percent by weight
Carbon .....1.4 percent by weight

An analysis of the evolved gas is

Hydrogen .....42.8 percent by volume
Methane .....54 percent by volume
Ethylene ..... 2.8 percent by volume
Higher olefins ..... .4 percent by volume

### Higher Hydrocarbons

Thermal decomposition of higher molecular weight hydrocarbons produces higher yields of aromatic hydrocarbons. The optimum temperature for the formation of aromatics from cracking propane is about 1472° F. Groll[3] passed propane through a steel tube at 1472° F. and obtained the following:

Percent by weight of gas.....83.5
Percent by weight of tar.....16.5

Composition of the tar:

Benzene .....37 percent by weight
Toluene ..... 7 percent by weight
Xylene and styrene..... 4 percent by weight
Naphthalene .....18 percent by weight
Anthracene and phenanthrene..10 percent by weight

In the presence of a nickel catalyst propane will begin to dissociate at as low a temperature as 392° F. It will break down rapidly at 750° F., whereas without catalysts it is stable to 860° F.

### Polymerization of Acetylene

Kato[4] obtained a 90 percent yield of polymerization products (mostly benzene) from acetylene at 1166° F. by mixing the preheated hydrocarbons with inert gases at high temperature and then cooling rapidly.

Gros[5] heated a mixture of 50 percent acetylene and 50 percent hydrogen to 1076° F. to produce a mixture of hydrocarbons containing 38 percent benzene, 3 percent toluene and 7 percent naphthalene.

When a mixture of acetylene (9 percent) and hydrogen is passed over an iron-nickel catalyst at a temperature of 482° F., a 60 percent conversion into

a liquid is obtained. Two thirds of the liquid is benzene.

### Decomposition of Ethylene and Propylene

Ethylene was passed through a quartz tube at 1382° F. to form 13 percent by weight of aromatic hydrocarbons.

Groll[5] passed propylene through a KA-2 steel tube at 1472° F. and obtained a yield of 40 percent by weight of tar, composed mainly of aromatic hydrocarbons:

| | |
|---|---|
| Benzene | 37 percent by weight |
| Toluene | 7 percent by weight |
| Naphthalene | 18 percent by weight |
| Anthracene and phenanthrene | 10 percent by weight |

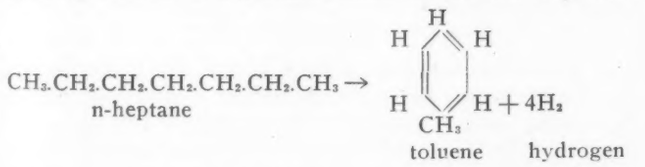
### Petroleum Naphthas

The use of a catalyst lowers considerably the temperature necessary to form aromatics from petroleum fractions. For example, six 45° F. fractions between 302 and 572° F. from a naphthene-base crude oil were treated by Egloff and Moore[6] with aluminum chloride at about 212° F. for a period of 12 hours. The material boiling below 212° F. was removed as soon as it was formed. Gasoline was formed from the oils to the extent of 18-32 percent. The maximum conversion occurred with the oil of higher boiling point. Lower temperatures were favorable to higher yields of aromatics,

| | 302° F. | 392° F. |
|---|---|---|
| Benzene | .8 percent | 0 percent |
| Toluene | 2.3 percent | 1.6 percent |
| Xylene | 7.9 percent | 3.6 percent |

### Hydroforming

Hydroforming is a catalytic process in which a heavy paraffinic naphtha for example is passed over a catalyst in the presence of hydrogen for the manufacture of aromatic hydrocarbons. Several commercial units are in operation. Naphtha of 40-octane number is passed over a granular catalyst at a temperature of 1000° F. along with a preheated stream of hydrogen-containing gas derived from the tail gases. An 80-percent yield of 80-octane naphtha is produced. Coke is deposited on the catalyst, making it necessary to switch chambers and revive the catalyst periodically. The general reaction is a dehydrogenation of a paraffin such as normal heptane:




The normal hydroformed gasoline contains 40-50 percent of aromatics. From 15-20 percent of the aromatics is toluene, with the greater part of the balance being xylenes and higher aromatics. By modifying the plant equipment and operation, it is claimed that a yield of 80 percent of aromatics can be produced. Thus the output of toluene alone from one 7500-barrel-per-day plant would be 5,000,000 gallons per year, or 25 percent of the 1939 United States production.

### Polyform and Gas Reversion

Gulf Oil Corporation and Phillips Petroleum Company have developed the Polyform Process, and a number of commercial units have been in operation for six years or more. Naphtha or gas oil is cracked in the presence of a definite percentage of propane and butane hydrocarbons. The light hydrocarbons are introduced into the cracking feed in order to increase the conversion per pass and in order to permit certain side reactions. Temperatures of 1030 and 1130° F. are used for naphtha reforming. Analysis of the polyformed distillate shows the following aromatic content:

| | |
|---|---|
| Benzene | 4.4 percent |
| Toluene | 10.7 percent |
| Xylene | 11.6 percent |

### Forward Process

Test runs on a semi-commercial Forward cracking unit[7] charging a gas oil and heating to 1060° F. produced a motor fuel containing 85-90 percent of aromatic hydrocarbons. This product contained as many aromatic compounds as are present in coal tar produced by the destructive distillation of coal. The majority of the compounds were substituted benzenes. The following properties are characteristic of the type of products:

| | |
|---|---|
| Gravity, A.P.I. | 31.3 |
| I.B.P | 133° F. |
| 10 percent distills at | 217 |
| 50 percent distills at | 266 |
| 90 percent distills at | 343 |
| End point | 399 |
| Freezing point | below —90° F. |
| Aniline point | 32° F. |

### Analysis

The hydrocarbon analysis of motor fuels, or light hydrocarbon fractions, is usually carried out by first estimating and removing the unsaturated hydrocarbons, which are the most active constituents, and then examining the olefine-free oil for aromatics and other hydrocarbons. The estimation of aromatics has been carried out by the following methods:

1. By specific gravity and refractive index measurements.
2. By treatment with concentrated sulfuric acid.
3. By means of critical solution temperature measurements in various solvents.
4. By treatment with nitric acid and other nitrating agents.
5. By means of solvents and other methods.

### Specific Gravity and Refractive Index Method

This method of analysis is based on the fact that of the four main classes of hydrocarbons, the aromatics have the highest specific gravities and refractive indices. Consequently, the removal of aromatics causes a reduction in both of these properties. Thole[8] divides the oil into three portions, (1) 104-203° F., (2) 203-252° F., (3) 252-302° F., it being assumed that these three fractions contain all of the benzene, toluene and xylenes, respectively. These fractions are sulphonated and the differences in specific gravity of the fractions, before and after sulphonation and removal of the aromatics, are used for the calculation of the aromatic content.

$$\text{Percent aromatics by vol.} = \frac{100\,(d_1 - d_2)}{D - d_2}$$

where

D is specific gravity of aromatics only
$d_1$ is specific gravity of the oil before removal of aromatics
$d_2$ is specific gravity of the oil after removal of aromatics.

Note: It is necessary to apply a correction factor for an error in the volume.

### Sulfuric Acid Method

Considerable work has been done to find the proper strength of acid, with perhaps a catalyst, to selec-

tively remove the aromatics without at the same time dissolving paraffins or naphthenes. The standard method adopted by the British Institute of Petroleum Technologists consists of treating the oil with twice its volume of 98 ± 1 percent sulfuric acid for 15 minutes. The acid layer is withdrawn and the acid treatment repeated for two further periods of 15 minutes each, using one volume of acid. The aromatic hydrocarbon content is determined by measuring the difference in aniline point of the fraction before and after such treatment.

$A = n(T - T_1)$ where
A is the percent of aromatic hydrocarbons by weight
n is a constant. 1.19 for benzene. 1.20 for toluene. 1.23 for xylene.
T is the aniline point after removal of aromatics.
$T_1$ is the aniline point before removal of aromatics.

### Nitration Method

Aromatic hydrocarbons may be nitrated with ease; so several methods of analysis have been based on this reaction. One method is to nitrate the oil in a vessel with a narrow graduated neck. The resulting nitro-bodies are then dissolved in sulfuric acid (95 percent), added in such quantity that the unchanged oil appears in the graduated portion, where its volume can be read.

### Chemical Properties of the Aromatics

The benzene hydrocarbons are for the most part colorless liquids, insoluble in water, but readily soluble in alcohol and ether. They distill without decomposition, possess a peculiar and sometimes pleasant ethereal odor, and burn with a smoky flame. The anti-knock values of the aromatics are high, making this group highly desirable for motor fuel. The relatively long ignition lag makes the aromatics undesirable for diesel fuel. The smoky flame makes this class of hydrocarbons undesirable as a constituent of kerosine and other burning oils.

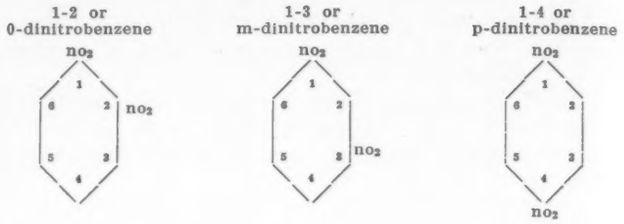
The chemical properties which are characteristic of benzene and its derivatives are often spoken of as "aromatic properties." These include (a) resistance to oxidation, (b) acidic properties of the hydroxyl derivatives (for example, carbolic acid), (c) failure to add reagents which usually add to the unsaturated compounds, and (d) the ready substitution of hydrogen by other atoms or groups.

Many different types of compounds are included under the general designation of aromatic hydrocarbons, but the members of all the different classes are alike in containing at least one benzene nucleus in the molecule. All aromatic hydrocarbons, therefore, may be regarded as derivatives of benzene, the differences between the various groups into which these substances are broadly classified depending on differences in the number, nature and method of attachment of the individual rings present.

### Isomerism

If one of the hydrogen atoms of benzene is replaced by another element or group, the resulting mono-substitution product exists in only one form. There is only one methyl benzene, $C_6H_5CH_3$, one chlorobenzene, $C_6H_5Cl$, etc. Since all of the hydrogen atoms are equivalent, it is immaterial which position in the benzene ring is assigned to the single substituting element.

When, however, two hydrogen atoms of benzene are replaced by two monovalent elements or radicals, the relative positions of the substituents are of considerable importance in determining the properties of the compound. All of the disubstitution products of benzene exist in three isometric forms. For example,

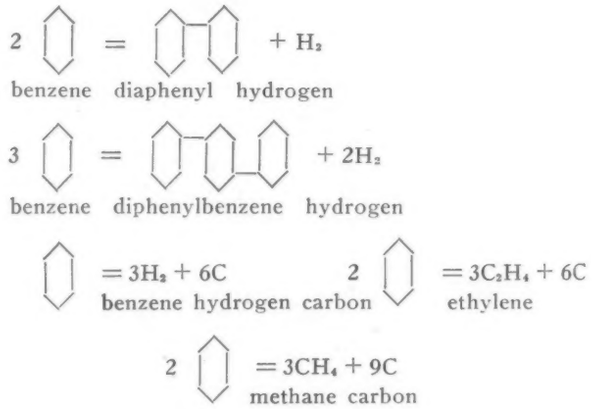



The position of the substituted element or radical affects the properties considerably:

| | Melting Point | Boiling Point |
|---|---|---|
| 1-2 dinitro benzene ..... | 244 F. | 606 F. |
| 1-3 dinitro benzene..... | 193 F. | 577 F. |
| 1-4 dinitro benzene..... | 344 F. | 570 F. |

### Thermal Stability

The aromatic hydrocarbons as a group are more stable to thermal decomposition than any of the other groups of hydrocarbons. The following examples show that temperatures in excess of 1000° F. are necessary to decompose the aromatics. Higher aromatic hydrocarbons make up the greater part of the decomposition products. Benzene decomposes at temperatures of 1112 to 1472° F. to form carbon, hydrogen, diphenyl, diphenyl benzene. The use of certain catalysts lowers the temperature of decomposition to 750° F. and lower. The decomposition reactions are as follows:




Ferko[9] decomposed toluene at red heat. The liquid products were benzene, toluene, naphthalene, anthracene, and diphenyl. The gaseous products are hydrogen with small amounts of methane. Toluene will begin to decompose at 1025° F. The treatment of toluene with aluminum chloride at reflux temperature produced benzene, xylene, higher methylated benzene, and di tolyl methane.

The decomposition products of xylene at a "moderate red" heat are benzene, toluene, naphthalene, anthracene, and xylene.

### Substitution Reactions

The many industrial uses of the aromatic hydrocarbons in both peacetime and wartime chemicals are based to a great extent on the following reactions:

Halogenation, or the substitution of chlorine or bromine for a hydrogen atom:

$C_6H_6 + Cl_2$ (with iron as a catalyst) $= C^6H_5Cl + HCl$

Nitration, or the substitution of hydrogen for a nitro group:

$$C_6H_6 + HNO_3 = C_6H_5NO_2 + H_2O$$

Sulfonation, or the substitution of hydrogen by the sulfonic acid group:

$$C_6H_6 + H_2SO_4 = C_6H_5SO_3H + H_2O$$

Friedel and Craft's reaction, or the introduction of an alkyl or acyl group by means of the corresponding halide and aluminum chloride:

$$C_6H_6 + C_2H_5Br \text{ (with } Al\,Cl_3) = C_6H_5C_2H_5 + HBr.$$

Some typical illustrations of these reactions are shown in the following commercial chemical products:

### Synthetic Rubber

Buna S, a synthetic rubber, is a polymerized product of the two chemicals styrene and butadiene. Styrene is a benzene compound. Benzene and ethylene combine in the presence of aluminum chloride catalyst to form ethyl benzene. The ethyl benzene is dehydrogenated to form styrene:

$$\underset{\text{benzene}}{C_6H_6} + \underset{\text{ethylene}}{CH_2:CH_2} \rightarrow \underset{\text{ethyl benzene}}{C_6H_5CH_2CH_3} \rightarrow \underset{\text{styrene}}{C_6H_5CH:CH_2} + \underset{\text{hydrogen}}{H_2}$$

### Explosives

Tri-nitrotoluene, TNT, 1-$CH_3$ 2,4,6 $(NO_2)_3.C_6H_2$, is made by nitrating toluene. The nitration is performed in three steps, in a steel vessel equipped with an agitator and coils which may receive steam for heating or water for cooling. First the mono-nitrotoluene is made with the use of a mixed acid containing 60 percent sulfuric, 14 percent nitric, the balance water. Further nitration is affected with a stronger acid solution, 67 percent sulfuric and 16 percent nitric. A final nitration with 40 parts sulfuric and 60 parts nitric produces the "tri" mix. The tri-nitrotoluene is washed, treated with sodium sulfite solution, dried, and flaked. It forms pale yellow flakes.

$$\underset{\text{toluene}}{C_6H_5CH_3} + \underset{\text{nitric acid}}{HNO_3} = \underset{\text{TNT}}{C_6H_2(NO_2)_3CH_3}$$

Picric acid, 1-OH2,4,6 $(No_2)_3.C_6H_2$, is made by nitration of phenol which has previously been treated with sulfuric acid to form phenol disulfonate. The picric acid separates in the form of yellow crystals, which are washed and dried.

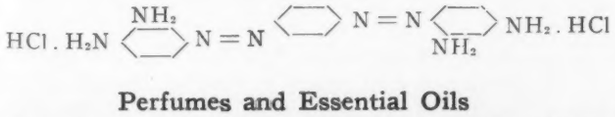
$$\underset{\text{phenol}}{C_6H_5OH} + 3\,\underset{\text{nitric acid}}{HNO_3} = \underset{\text{picric acid}}{C_6H_3(NO_3)_3OH} + 3\,\underset{\text{water}}{H_2O}$$

Tetryl is tri-nitro-phenyl-methyl-nitramine, a yellow powder, and is made by the nitration of dimethyl aniline. Tetryl is a booster explosive and is the standard bursting charge for small anti-aircraft guns.

Hexyl is hexa-nitro-diphenyl amine. Ammonium picrate is another explosive made from aromatic bases.

### Dyes

The production of synthetic dyes has long outstripped the natural dye production. The majority of the synthetic dyes contain the benzene radical. For example, Bismark Brown is the hydrochloride of a basic azo dye containing four amino groups:



### Perfumes and Essential Oils

Formerly the material used by the perfume maker was entirely blended with natural products. A large number of synthetic products are now used as both the finished product or as a supplemental ingredient of the finished product. The use of synthetics has reduced the price of essential oils considerably. For example, the oil extracted from the natural flower, the violet, cost $75 per ounce. Today, most violet perfumes are made from methyl ionone, a relatively inexpensive aromatic semi-synthetic. Artificial musk is made from cresol as its base.

### Plastics

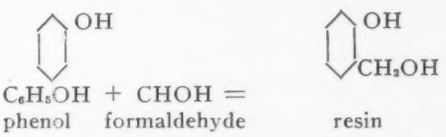
The rise in the production of phenol resins of various kinds made it imperative that sources of phenol other than from coal tar be found. In 1940, 24 million pounds of natural and 72 million pounds of synthetic phenol were produced. Synthetic phenol is made from benzene by one of three methods: sulfonation followed by alkaline fusion, or by chlorination and subsequent heating under pressure with caustic soda solution, or by the hydrolysis of chlorbenzene. The reactions of the latter process are as follows:

$$\underset{\text{benzene}}{C_6H_6} + \underset{\substack{\text{hydro-}\\\text{chloric}\\\text{acid}}}{HCl} + \underset{\text{oxygen}}{\tfrac{1}{2}O_2} + \underset{}{\text{catalyst}} = \underset{\text{chlorbenzene}}{C_6H_5Cl} + \underset{\text{water}}{H_2O}$$

The chlorbenzene is hydrolized catalytically with steam:

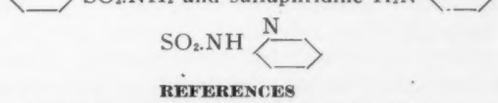
$$\underset{\text{chlorbenzene}}{C_6H_5Cl} + \underset{\text{water}}{H_2O} = \underset{\text{phenol}}{C_6H_5OH} + \underset{\text{hydrochloric acid}}{HCl}$$

Phenol is an important ingredient in several types of resin plastics. The process of manufacture of resins is relatively simple. The process consists of heating two liquid, or a solid and a liquid, to produce the reaction, removing any water formed, then heating further until the proper melting point and viscosity is obtained. For example, equal parts of liquid phenol and 40 percent formaldehyde are placed in a kettle fitted with a reflux condenser. About .25 to 2.5 percent catalyst is added and heat is applied. After 2 hours or so of boiling, the water is drawn off and the resin is drawn into the proper molds.




### Pharmaceuticals

Today many natural medicines are supplemented with or replaced by synthetic products. Neosalvarsan, the specific for syphilis, is a benzene derivative. Quinine sulfate from the bark of the cinchona tree is an antipyretic; it is supplemented by the synthetics acetanilide, used for headache powders (bromo-seltzer), and acetyl salicylic acid (aspirin). Novocaine is a synthetic anesthetic. Phenolphthalein is a widely used synthetic laxative. The most important aromatic synthetics are the new sulfa-drugs, sulfanilamide,





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# Some Factors Affecting The Economics of Gas Cycling Plant Design

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THE recovery of liquefied products from gas-condensate (or distillate) fields is carried out for the most part in centralized plants since a number of the larger fields such as Cotton Valley, Katy and Erath have been unitized. The pooling of interests in the installation of such plants results in the application of the best engineering practices in the design and planning of these projects. Well-qualified engineers from the several companies involved usually make up an engineering committee which is largely responsible for the design and operation of the field and plant equipment.

### Preliminary Surveys

There are a number of engineering studies to be made before final consideration is given toward the design of a condensate and natural-gasoline-recovery plant.

1. The estimation of the condensate, natural gasoline and dry gas reserves of the field, based on geological and physical test data.

2. An electrolytic model study of the field in order to determine the arrangement of input and porducing wells for the best flooding pattern.

3. A study of market outlets for liquefied and gaseous products.

### Plant Design—Oil Absorption vs. Stage Separation

The trend in the construction of these recovery plants has been toward the installation of high-pressure oil absorption units. It was thought several years ago that stage separation would take the lead in this branch of the oil industry due to the low initial investment required. The increased demand for natural gasoline, butanes and propane has been one factor which has favored the erection of absorption plants.

The problem of selecting the optimum pressure for the absorption unit is not an easy one as the cost of recompressing the gas for injection back into the formation must be balanced against the recoveries obtainable at different pressures. In other words it may be good economy to sacrifice some condensate production in order to lower gas-compression costs. Or it may be better to circulate more absorption oil rather than to operate the absorbers at the pressure requiring the minimum oil circulation so as to save on compression cost.

Proper balance between the size of the gathering lines and the compressor plant is governed by so many factors that each situation calls for its own solution. If the reservoir fluid is rather low in condensate content, it may be desirable to reduce the plant inlet pressure to one half of the reservoir pressure or even less in order to get good recoveries. In such a case, the size of the gathering lines might well be reduced in size since the compressors would be required to boost the dry gas back up to the reservoir pressure. If the reservoir has a low permeability, the loss in pressure through the formation might be so great that very little friction loss could be tolerated in the gathering lines.

High temperatures in the reservoir itself are apt to present the problem of precooling the incoming raw "gas" to the plant. The lowering of the reservoir-fluid temperature is desirable both from the standpoint of absorption efficiency and the increase in compressor capacity, however, this practice may call for a dehydration unit on the plant inlet so as to avoid freeze-ups in winter.

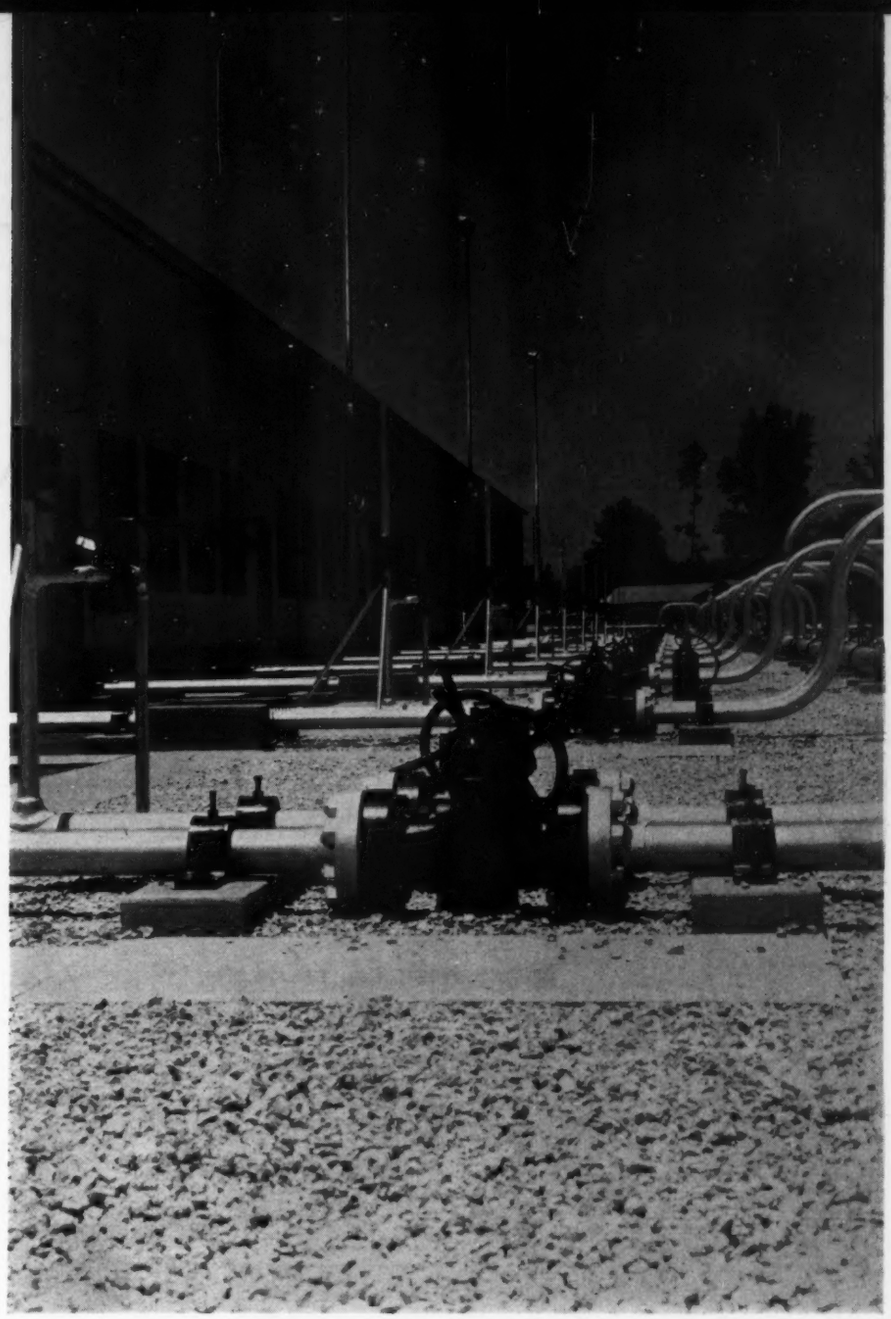
Since these large condensate fields will probably continue to produce liquefied products until the content of the reservoir fluid (raw gas) is quite low, this fact should be taken into consideration although the original content may be as high as several gallons per thousand standard cubic feet. The lower gas-content limit towards which a plant could operate at a profit would depend largely upon the market price of the liquefied products in the depleted stage of the field's life.

### Two- and Three-Stage Compression

Most cycling plants should be able to operate satisfactorily with one compression stage, as long as the compression ratio remains below 2.5 to 3.0 (ratio of discharge to inlet pressure). In some fields, however, where gas lift might be employed, several stages of compression are apt to be required. The hot gas from the discharge of each stage is usually cooled down to the original intake temperature before the gas is taken into the next higher stage of compression. Each compression cycle falls between the isothermal and the adiabatic, or in other words it is polytropic. The

**ABSTRACT**

**DUE to the heavy demand for the lighter hydrocarbons, the trend in the construction of condensate-recovery plants has been toward the installation of centralized oil absorption plants. Each field presents its own problems such as that of the selection of optimum operating pressures and temperatures, depending upon the composition of the reservoir fluid to be processed. Other factors such as the balancing of gas-compression cost against the recovery of condensate and natural gasoline are discussed. Mathematical derivation are given for the determination of the optimum interstage pressures whenever the ratio of discharge pressure to intake pressure runs too high for economical single stage operation.**



Intake and return manifolding for return of dry gas to the two formations, which are being produced in the Cotton Valley field.

heat removed by the compressor water jacket is so small, however, that the compression may be considered adiabatic for all practical purposes.

The most economical interstage pressure for two-stage compression with intercooling back to the temperature of the first-stage inlet can be determined by the calculus by setting up an equation for the work performed by the two compression stages on the gas and differentiating the total work with respect to the variable interstage pressure. The differential is set equal to zero and a solution obtained for the maximum work to be done by the compressors on the gas. Equating the differential to zero does not necessarily mean that the result will give the desired value as an equation may have several solutions represented by a maximum, a minimum or a point of inflection any one of which would represent a point where the slope of the curve is zero.

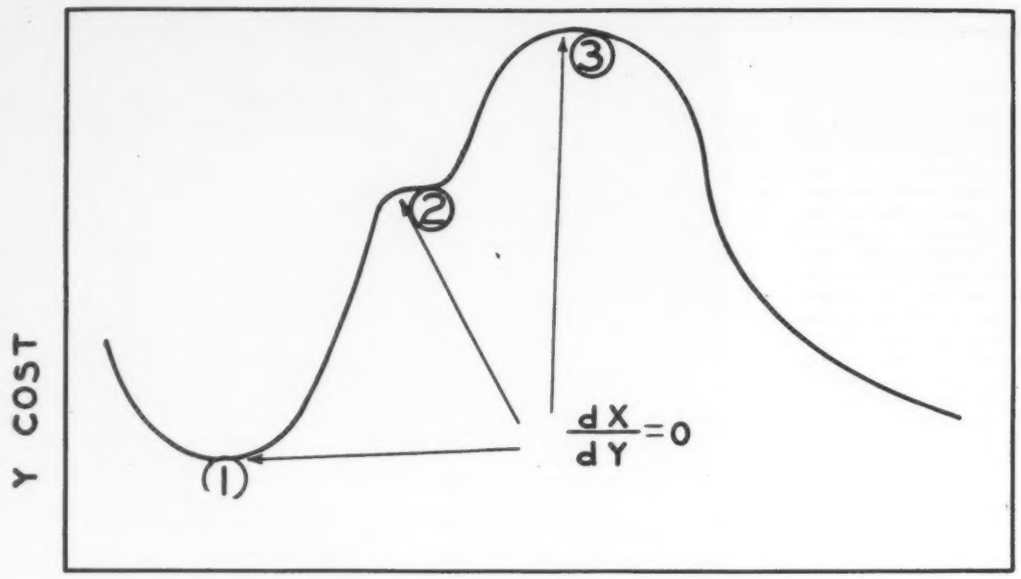
### Tests for Different Points of Zero Slope

There are two ways to test such a result so as to determine whether it is a minimum, a maximum or a point of inflection. By taking the second derivative or the rate of change of the slope of the curve it is found that a negative value for the second derivative indicates a maximum, that is the slope is going toward a negative value. When the second derivative is positive, a minimum in the curve is indicated, while a zero value for the second derivative means a point of inflection. These relationships which have just been described can be understood more easily by reference to Figure 1 on which the several points in question are located.

The other method of testing for maximum, minimum or point of inflection is to take values greater and less than the one representing the zero slope. If each of these values gives a higher point on the curve, the zero slope represents a minimum, lower points on each side represent a maximum while a point of inflection is represented by a higher value on one side and a lower value on the other side of the point at zero slope.

### Optimum Interstage Pressure for Two-Stage Compression

If the discharge temperature of the gas from each compression is lowered to the temperature of the in-




① MINIMUM $\frac{d^2X}{dY^2} > 0$

② INFLECTION $\frac{d^2X}{dY^2} = 0$

③ MAXIMUM $\frac{d^2X}{dY^2} < 0$

FIGURE 1
Curve showing the relationship of cost to some variable.

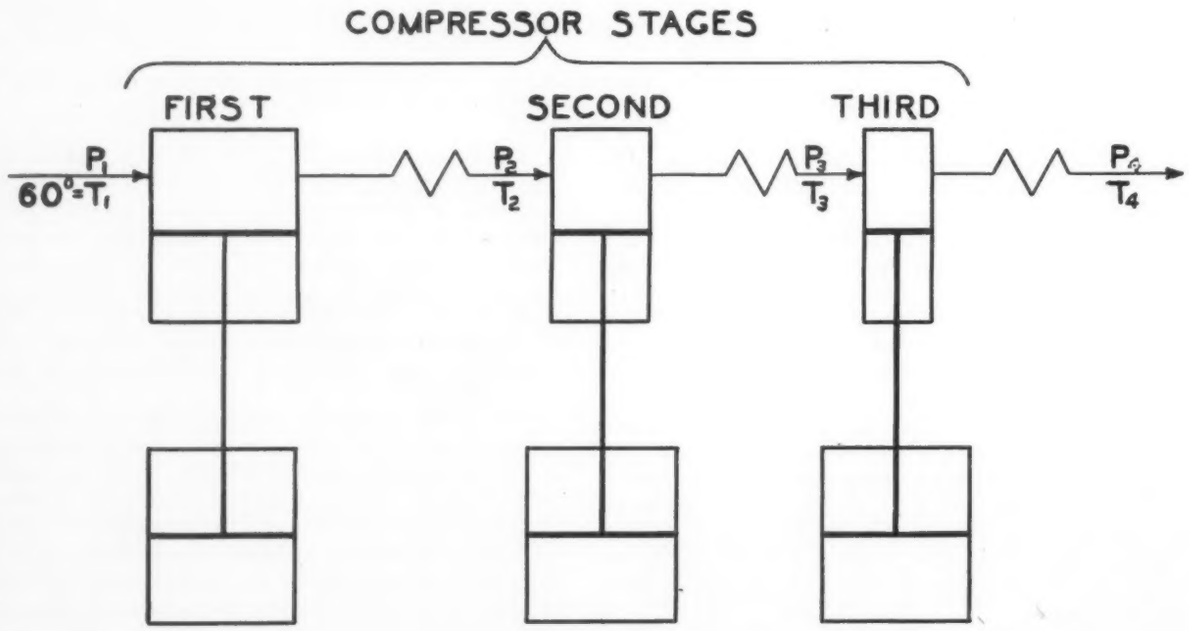



FIGURE 2
Diagramatic sketch of three stage compression.

take of the low-stage unit, the formula for the adiabatic work done by the system (the engine) on the surroundings (the compressors) is as follows:

1. $W_1 = N\,R\,T\left(\frac{K}{K-1}\right)\left[1-\left(\frac{P_2}{P_1}\right)^{\frac{K-1}{K}}\right]$ (First stage of compression)

2. $W_2 = N\,R\,T\left(\frac{K}{K-1}\right)\left[1-\left(\frac{P_3}{P_2}\right)^{\frac{K-1}{K}}\right]$ (Second stage of compression)

Adding equations 1 and 2 we get,

3. $\Sigma W = N\,R\,T\left(\frac{K}{K-1}\right)\left[2-\left(\frac{P_2}{P_1}\right)^{\frac{K-1}{K}}-\left(\frac{P_3}{P_2}\right)^{\frac{K-1}{K}}\right]$

The work done by the compressors (the surroundings) on the gas (the system under consideration) is the negative of (3):

4. $(-\Sigma W) = N\,R\,T\left(\frac{K}{K-1}\right)\left[-2+\left(\frac{P_2}{P_1}\right)^{\frac{K-1}{K}}+\left(\frac{P_3}{P_2}\right)^{\frac{K-1}{K}}\right]$

Where

$\Sigma W$ = Total work of the two stages.
N = Number of pounds mols or gas.
R = Universal Gas Constant or 1544 ft. lbs. per °F. per lb. mol.
T = Temperature in °F. ats = °Rankine.
K = Ratio of specific heat of gas at constant pressure to that at constant volume.
$P_1$ = Intake pressure to first stage in lbs. per square foot absolute.
$P_2, P_3$ = Intake and discharge pressures respectively of second stage. (In case of a ratio, pressures may be expressed in lbs. per square inch.)

Differentiating the total work with respect to the interstage pressure, ($P_2$) since $P_1$, and $P_3$ may be considered constants, we have:

5. $\frac{d(-\Sigma W)}{dP_2} = N\,R\,T\left(\frac{K}{K-1}\right)\left[P_1^{\frac{(1-K)}{K}}\left(\frac{K-1}{K}\right)P_2^{\left(\frac{-1}{K}\right)} - P_3^{\frac{K-1}{K}}\left(\frac{K-1}{K}\right)P_2^{\frac{1-2K}{K}}\right] = 0$

Solving, $P_3^{\frac{-1}{K}}\,P_2^{\frac{2K-1}{K}} = P_3^{\frac{K-1}{K}}\,P_1^{\frac{K-1}{K}} = P_2^{\frac{2(K-1)}{K}}$

$P_2^2 = P_3\,P_1$

$P_2 = \sqrt{P_3\,P_1}$

Taking a practical case, in which the intake pressure of the first stage is equal to atmospheric pressure (14.7 lb. square inch absolute) and the discharge of the second stage is 100 lb. sq. inch gage (114.7 lb. square inch absolute) the optimum interstage pressure would be:

6. $P_2 = \sqrt{P_1\,P_3} = \sqrt{14.7 \times 114.7}$
$= 41$ lb. sq. in. absolute
or $41 - 14.7 = 26.3$ lbs. sq. in. gage.

In order to test equation (5) to see whether the solution gives a maximum, the second derivative may be taken:

7. $\frac{d^2(-\Sigma W)}{dP_2^2} = \left[P_1^{\left(\frac{1-K}{K}\right)}\left(\frac{1}{K}\right)P_2^{\left(\frac{-1-K}{K}\right)} - P_3^{\frac{K-1}{K}}\left(\frac{1-2K}{K}\right)P_2^{\frac{1-2K}{K}}\right]$

Since the value of the right hand side is negative, the slope is passing through a maximum, or in other words, the maximum amount of work obtainable by the compressors would be forthcoming when the pressures vary according to equation (6).

## Optimum Interstage Pressures for Three-Stage Compression

In this we have two variables, namely the two in interstage pressures $P_2$ and $P_3$ on the discharge of stages one and two respectively. The mathematical solution is obtained in a somewhat similar manner to the solution of $P_2$ in two-stage compression.

The work for the three stages may be expressed as follows:

8. $-W$ (1st stage) $= N\,R\,T\left(\frac{K}{K-1}\right)\left[\left(\frac{P_2}{P_1}\right)^{\frac{(K-1)}{K}} - 1\right]$

9. $-W$ (2nd stage) $= N\,R\,T\left(\frac{K}{K-1}\right)\left[\left(\frac{P_3}{P_2}\right)^{\left(\frac{K-1}{K}\right)} - 1\right]$

10. $-W$ (3rd stage) $= N\,R\,T\left(\frac{K}{K-1}\right)\left[\left(\frac{P_4}{P_3}\right)^{\frac{(K-1)}{K}} - 1\right]$

11. Total Work $(-\Sigma W) = N\,R\,T\left(\frac{K}{K-1}\right)\left[\left(\frac{P_2}{P_1}\right)^{\frac{K-1}{K}} + \left(\frac{P_3}{P_2}\right)^{\left(\frac{K-1}{K}\right)} + \left(\frac{P_4}{P_3}\right)^{\frac{K-1}{K}} - 3\right]$

By taking $P_1$, $P_3$ and $P_4$ as constants, we can differentiate the total work with respect to $P_2$ in order to find the optimum pressure between the first and second stages.

12. $\frac{d(-\Sigma W)}{dP_2} = N\,R\,T\left(\frac{K}{K-1}\right)\left[P_1^{\frac{1-K}{K}}\left(\frac{K-1}{K}\right)P_2^{\frac{-1}{K}} + P_3^{\frac{K-1}{K}}\left(\frac{K-1}{K}\right)P_2^{\frac{1-2K}{K}}\right] = 0$

or $P_1^{\left(\frac{1-K}{K}\right)}\,P_2^{\frac{-1}{K}} = P_3^{\left(\frac{K-1}{K}\right)}\,P_2^{\frac{1-2K}{K}}$

which upon further rearrangement gives:

$P_2^{\left(\frac{1-2K}{K}\right)}\,P_2^{\left(\frac{1}{K}\right)} = P_2^{2\left(\frac{1-K}{K}\right)} = P_1^{\left(\frac{1-K}{K}\right)}\,P_3^{\left(\frac{1-K}{K}\right)}$

Taking the $\left(\frac{K}{1-K}\right)$ root of each side, we get

$P_2^2 = P_1\,P_3 \qquad P_2 = \sqrt{P_1\,P_3}$

Differentiating total work with respect to $P_3$, we have:

13. $\frac{d(-\Sigma W)}{dP_3} = N\,R\,T\left(\frac{K}{K-1}\right)\left[P_2^{\left(\frac{1-K}{K}\right)}\left(\frac{K-1}{K}\right)P_3^{\frac{-1}{K}} + P_4^{\frac{K-1}{K}}\left(-\frac{K-1}{K}\right)P_3^{\frac{1-2K}{K}}\right] =$

which obviously gives upon simplification a somewhat similar solution to that shown above.

14. $P^3 = \sqrt{P_2\,P_4}$

To express $P_2$ and $P_3$ in terms of $P_1$ and $P_4$ the original constants, we can take the following steps:

$P_3 = [P_1^{1/2}\,P_3^{1/2}\,P_4]^{1/2} = P_1^{1/4}\,P_3^{1/4}\,P_4^{1/2}$
$P_3\,P_3^{-1/4} = P_1^{1/4}\,P_4^{1/2} = P_3^{3/4}$ or,
$P_3 = (P_1^{1/4}\,P_4^{1/2})^{4/3}$ or $P_3 = P_1^{1/3}\,P_4^{2/3}$

Solving for $P_2$ in a similar manner we get: $P_2 = P_1^{2/3}\,P_4^{1/3}$

(Please refer to Figure 2)

Taking a special case (please refer to Figure 2) of three-stage compression with $P_1$ = atmospheric and $P_4 = 615.3$ pounds per square inch gage or 630 pounds per square inch absolute.

$P_2 = P_1^{2/3}\,P_4^{1/3} = 14.7^{2/3} \times 630^{1/3}$
$P_2 = 51.5$ lbs. per sq. in. absolute or 36.8 lbs. square inch gage.

Solving for $P_3 = P_1^{1/3}\,P_4^{2/3}$, we get:

$P_3 = 14.7^{1/3} \times 630^{2/3}$
$P_3 = 180$ lbs. per square inch absolute or 165.3 lbs. per sq. inch gage.

It is easily seen that the optimum interstage pressures are such that the compression ratio of each stage is a constant, or $P_1/P_2 = P_2/P_3 = P_3/P_4$, or a compression ratio of 3.5. A ratio this high in a main-line gas station would be far too high to be economical, but it might be considered good practice for a short-lived gas-lift station where the time for a pay-out is much shorter.

# Some Uses of Infra-Red Spectroscopy For Hydrocarbon Analysis*

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SEVERAL papers on the uses of spectroscopy in hydrocarbon research have been published recently. Nielsen[1], before the American Association for the Advancement of Science, gave a general review of the uses of spectroscopy in the petroleum industry and Wright[2] has discussed more particularly the industrial uses of infra-red spectroscopy. These are only two of the more recent papers contributing to this field, which derives some of the fundamental ideas from the work of Coblentz[3] published in 1905. It seems advisable to avoid duplication, and consequently this paper will be restricted, as much as possible, to infra-red methods and instruments usable for routine analysis in actual plant operation.

Three different types of energy change within a molecule give rise to its spectrum. Changes in the electronic energy of a molecule cause either emission or absorption of radiation in the ultra-violet or visible regions. Examples of this, often used for analytical purposes, are the absorption bands of aromatic compounds in the 2400-2700A range. Absorption in the ultra-violet region can be and is being used as a powerful analytical tool. However, paraffins and mono-olefins do not have characteristic absorptions, caused by electronic energy changes, in a wave-length region easily accessible. Practically all of their absorption is at shorter wave lengths than 2000A and, consequently, they cannot be studied unless vacuum spectrographs, either prism or grating, are used.

Spectra caused by changes in the rotational energies of molecules appear in the far infra-red. This region, whose short wave-length limit is usually taken as 30$\mu$, is not used for analysis because the experimental technique is too difficult.

The spectral region which we are discussing is referred to as the near infra-red and extends from 2$\mu$ to 30$\mu$. The actual analyses discussed only make use of absorption between 3$\mu$ and 15$\mu$ but the methods and instruments described could be used to 30$\mu$ with slight modifications. Molecular spectra in this region are caused by changes in the vibrational energy. The particular wave lengths or frequencies of radiation which a molecule absorbs are determined by the masses of the atoms forming the molecule, the forces between the atoms, and their relative positions. For the simpler molecules it is thus possible to correlate completely the absorption bands in this region with the normal vibrations of the molecule considered as a dynamical system. Such calculations are most useful when infra-red spectra are being used for purposes other than analysis.

* Presented before the Technical Committee of the California Natural Gasoline Association, seventeenth annual meeting, Los Angles, November 6, 1942.

The above facts can be restated in a form which indicates more explicitly what may be expected when using near infra-red spectra as the basis of analysis. In general the spectra of two molecules will be different when any of the three following conditions exist:

1. The molecules contain different atoms (methane and chloromethane).
2. The molecules contain the same atoms but the bonds between them are different (butane and butylene).
3. The molecules contain the same atoms held together by the same forces but the atoms are in different relative positions (n-butane and isobutane).

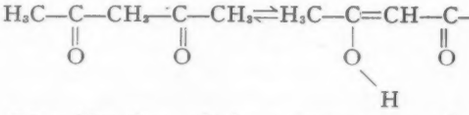
A fact, which is essentially the inverse of the above conditions, also aids in predicting the usability of infra-red absorpton as an analytical tool. This is that similar groups in different molecules will cause absorption at approximately the same wave lengths. Consequently, certain spectral positions are spoken of as characteristic of certain bonds. Vibrations which can be characterized as follows cause absorption approximately at the indicated wave lengths:

1. Stretching of a carbon-hydrogen bond.....3.2-3.4$\mu$
2. Stretching of a carbon-carbon single bond.... 8-12$\mu$
3. Stretching of a carbon-carbon double bond... 6-6.2$\mu$
4. Stretching of a carbon-carbon triple bond....$\backsim$4.5$\mu$
5. Stretching of a carbon-oxygen double bond...$\backsim$5.8$\mu$
6. Stretching of an oxygen-hydrogen bond.....2.7-2.9$\mu$
7. Bending of a hydrogen-carbon-hydrogen bond angle .....6.5-7.5$\mu$
8. Stretching of a sulfur-hydrogen bond.....$\backsim$3.85$\mu$

### Types of Analysis

From the above introduction it is seen that near infra-red spectra can be used on four types of analysis, namely:

1. Determination of the presence or absence of a particular chemical linkage in a compound of uncertain structure. Thus the existence of enol-keto tautomerism is often easily shown by the presence of both C=O and O—H absorption in the spectrum of the same molecule (e.g., acetylacetone



2. Identification of the components of a fraction which has been isolated by distillation or other means. Avery[4] has illustrated this use in the case of a cyclopentane cut.

3. Quantitative determination of a small amount of impurity in a supposedly pure substance. This has been thoroughly discussed by Wright[2] using different halogenated hydrocarbons as examples. Unfortu-

nately, some of the most elegant examples of this use of infra-red require a spectrograph of research rather than routine caliber.

4. The fourth type, routine quantitative analysis of mixtures of two or more components, and the instrument developed for this work will be discussed in detail below.

Any spectroscopic analytical procedure depends, from the simple standpoint, on finding a spectral position where only one of the components of a mixture

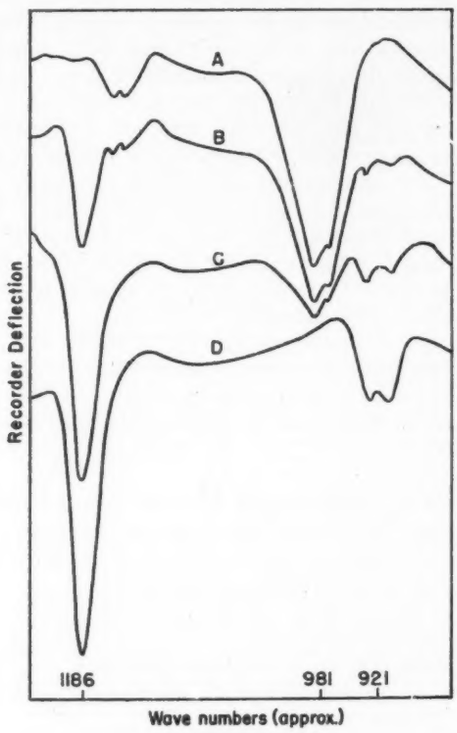



**FIGURE 1**
**Spectra of four samples containing different proportions of the butane isomers. A, 99.4 percent n-butane; B, 30 percent isobutane; C, 70 percent isobutane; D, 99.7 percent isobutane.**

absorbs strongly. However, the same absorption band may not serve to determine a particular component in two different mixtures. Consequently, the greatest simplicity and rapidity for routine analysis is achieved only when the analytical procedure is based on a detailed study of the specific mixture to be analyzed. This point is well illustrated by the analysis of butane mixtures which contain small amounts of propane and pentanes. If check analyses show that the amounts of propane and pentane remain below certain limits, a procedure which considers only the presence of the two butanes will serve to control an isomerization unit.

Regardless of the necessity of fitting the procedure to the mixture, certain general requirements can be stated for a spectroscopic analytical method which is to be used for routine analysis and plant control. The method should:

1. Be as rapid as is consistent with the precision required.

2. Yield the actual analysis from the experimental readings with a minimum of calculation.

3. Require only a simple procedure performed with a consistent and sturdy apparatus.

* The discussion of two component mixtures was first presented before the American Physical Society, Pasadena, California, June, 1941. (Phys. Rev., 60, 161, 1941) and was published by R. R. Brattain and O. Beeck, Jour. Appl. Physics, 13, 699 (1942).

### Analysis of n-Butane-Isobutane Mixtures*

For a two component sample, the above general requirements are fulfilled most easily by a system requiring only the determination of the percent transmission at a single spectral position. With such a system, the largest change in percent transmission per unit change in isobutane content is achieved by choosing the proper values of the three variables: spectral position, spectral slit-width and specific absorption path. The optimum values of these variables may change with changing isobutane content of the samples under investigation. However, a rapid routine analytical procedure must handle all samples with a minimum of adjustments for sample composition.

The spectra between the wave numbers 1250 and 870 of four different mixtures of the butane isomers are shown in Figure 1. It is seen that large differences exist in this region between the spectra of these isomers.

The absorption band of isobutane at 1186 cm.$^{-1}$ was chosen as the spectral position. This band is freest from interference due to n-butane and is closer to the energy maximum of the source than the other bands shown in Figure 1. The absorption maximum of this band is used as the exact spectral position in the case of butane mixtures. However, in the case of another mixture a position on the side of an absorption band may give a larger change in percent transmission per unit change of the unknown component. This situation could arise if interfering absorption bands are present.

The spectral slit-width chosen for the analysis of isobutane in n-butane was about 65 cm.$^{-1}$. This value was selected to give the maximum energy strongly absorbed by isobutane in this spectral region.

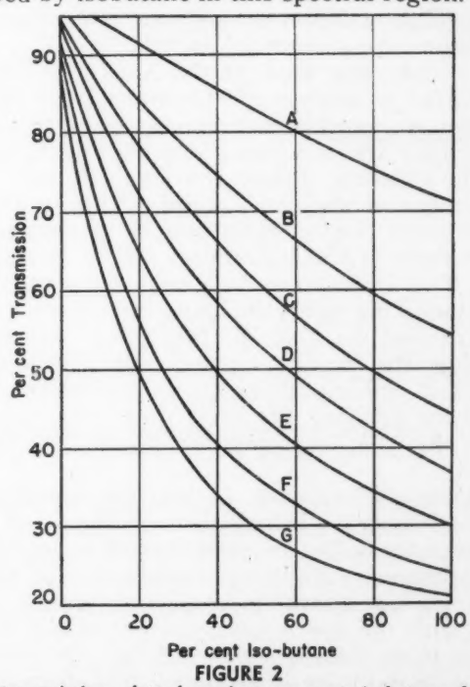



**FIGURE 2**
**Percent transmission plotted against perecent isobutane for various pressures (in mm. of Hg) of sample in a 15 cm absorption path. (A) 50 mm; (B) 100 mm; (C) 150 mm; (D) 200 mm; (E) 275 mm; (F) 375 mm; (G) 475 mm.**

Curves showing percent transmission plotted against percent isobutane for various gas pressures of the sample in a 15 cm. absorption cell are given in Figure 2. From these data, curve E (275 cm. pressure) was chosen as the most suitable over the entire 0 to 100 percent isobutane range and curve C (150

TABLE 1

| DATE ANALYZED | Percent Isobutane by Infra-red | Percent Isobutane Synthetic | Percent Isobutane Duplicate | LOW TEMPERATURE DIST. Percent Isobutane | Percent n-Butane | Percent Propane | Percent Pentane |
|---|---|---|---|---|---|---|---|
| 10/ 4/40 | 10.0 | 9.9 | .... | .... | .... | .... | .... |
| 10/ 9/40 | 45.8 | 45.6 | .... | .... | .... | .... | .... |
| 10/11/40 | 30.0 | 30.17 | .... | .... | .... | .... | .... |
| 10/11/40 | 45.9 | 45.6 | .... | .... | .... | .... | .... |
| 10/11/40 | 100.5 | 99.7 | .... | .... | .... | .... | .... |
| 6/11/41 | 20.1 | 19.86 | .... | .... | .... | .... | .... |
| 6/11/41 | 19.8 | 19.86 | .... | .... | .... | .... | .... |
| 6/11/41 | 29.8 | 30.17 | .... | .... | .... | .... | .... |
| 6/11/41 | 99.1 | 99.7 | .... | .... | .... | .... | .... |
| 7/14/41 | 20.0 | 20.12 | .... | .... | .... | .... | .... |
| 7/14/41 | 30.0 | 30.08 | .... | .... | .... | .... | .... |
| 7/14/41 | 40.0 | 40.08 | .... | .... | .... | .... | .... |
| 7/14/41 | 80.5 | 79.79 | .... | .... | .... | .... | .... |
| 10/14/41 | 43.5 | 43.9 | .... | .... | .... | .... | .... |
| 5/ 8/40 | 23.25 | .... | .... | 22.6 | 75.6 | 0.0 | 1.8 |
| ..... | 12.0 | .... | .... | 11.2 | 88.4 | 0.0 | 0.4 |
| ..... | 54.9 | .... | .... | 54.9 | 43.7 | 0.2 | 1.2 |
| 5/16/40 | 36.9 | .... | .... | 36.5 | 62.8 | 0.0 | 0.7 |
| ..... | 16.0 | .... | .... | 16.3 | 83.3 | 0.0 | 0.4 |
| ..... | 61.0 | .... | .... | 60.1 | 36.3 | 0.7 | 2.9 |
| 6/31/40 | 37.2 | .... | .... | 36.5 | 62.5 | 0.1 | 0.9 |
| 7/22/40 | 37.4 | .... | .... | 37.9 | 61.2 | 0.2 | 0.7 |
| 6/ 3/40 | 27.4 | .... | 27.7 | .... | .... | .... | .... |
| 6/10/40 | 48.4 | .... | 48.6 | .... | .... | .... | .... |
| 6/18/40 | 47.0 | .... | 47.5 | .... | .... | .... | .... |
| 6/11/40 | 22.2 | .... | 21.8 | .... | .... | .... | .... |

mm. pressure) was chosen as the best if the sample contains more than 70 percent isobutane. Samples whose compositions were accurately known were used to obtain these curves.

To summarize, the routine infra-red analysis of n-butane-isobutane mixtures is made as follows:

The energy traversing the instrument and composed of the spectral interval from 1217 to 1153 cm.$^{-1}$, is read both with and without the sample in the light path. From these readings, the percentage of energy transmitted by the sample is calculated. The isobutane content (in percent) is then read from a calibration curve. The calibration curve is plotted from readings taken on synthetic samples whose compositions are accurately known.

This system was used, at the Shell Development Laboratories, to analyze 5500 samples in 22 months. In addition, two special instruments using this analysis procedure are now being used for plant-control work. The accuracy of these routine analyses is about ±0.5 percent of the total sample. The accuracy is slightly better for samples low in isobutane and slightly worse if the isobutane content is above 85 percent. The time required for analysis is 20 minutes per sample. This figure includes time spent turning the instrument on and off, preparing the samples, calculating the results, periodically checking the method and making out analysis reports. It was arrived at by dividing the total time spent on these analyses by the total number (5500) of samples analyzed.

The time is 15 minutes or less per sample if the number of analyses is sufficient to require 8 hours continuous work by an experienced operator. The average time per sample was increased to 20 minutes because six operators were trained within the 22 months with the spectrophotometer seldom in operation for more than 4 hours per day. One operator analyzed 38 samples in 6 hours, including calculations and other operations incidental to the actual analyses.

### Accuracy Checks and Interference From Other Substances

The results of some of the checks of this infra-red method of analyzing butane mixtures are presented in Table 1. Three different bases of comparison are given:

1. Synthetic mixtures whose compositions are accurately known.
2. Values obtained by low-temperature distillation. The complete composition is given for these samples.
3. Duplicate spectroscopic values taken at least one day apart.

The accuracy of a low-temperature distillation analysis is about ±0.5 percent.

Propane, n-pentane, and isopentane are the impurities most likely to be present in a n-butane-isobutane sample. All of these compounds have some absorption in the region of the 1186 cm.$^{-1}$ isobutane absorption band. However, small quantities of these substances can be present without impairing the accuracy (0.5 percent) of the above simple analytical method. The maximum allowable amounts are 10 percent propane, 5 percent n-pentane, and 2.5 percent isopentane. Larger amounts of these impurities could be corrected for by readings at other wave lengths. This is possible on the routine spectrophotometer which will be described later.

None of the unsaturated four-carbon compounds, butenes and butadiene, have large enough absorption at 1186 cm.$^{-1}$ to cause small amounts of these compounds to interfere with this method of analyzing for isobutane.

### Analysis of Mixtures of Butene-1 and Butene-2

The same system of analysis has been applied to mixtures of butene-1 and butene-2. The values of the three variables for this analysis are:

1. Spectral position—absorption maximum of the butene-1 band at 1841 cm.$^{-1}$.
2. Spectral slit-width—about 65 cm.$^{-1}$.
3. Specific absorption path—400 mm. pressure of gas in a 15 cm. cell.

About 250 such samples have been analyzed by this infra-red method. The accuracy and time per sample are the same as for butane mixtures.

### Analysis for a Single Component in a Multi-Component Mixture

Determination of the amount of a particular component in a complicated mixture is sometimes possible using only a reading of the absorption at one spectral position. This situation usually exists when the component of interest is markedly different in structure from the rest of the components, which are similar in structure. A possible example of this would be the determination of a ketone in a mixture of benzene homologues. However, it should be emphasized that such an analysis would have to be developed as a particular case.

### Analysis for All the Components in a Multi-Component Mixture*

A mixture of methane, ethane, ethylene, propane, and propylene will be used to illustrate the development of a procedure for the analysis of a multi-component mixture by infra-red absorption. Analysis of this mixture has not been developed; however, it serves as a good example.

The time involved in mixing standards and determining the curves to show the percentage of one component as a function of transmission at a particular position, is prohibitive when the percentages of the other components can vary arbitrarily. Hence the following semi-theoretical approach is used. For

* A more detailed discussion of the analysis of multi-component mixtures is being prepared for publication.

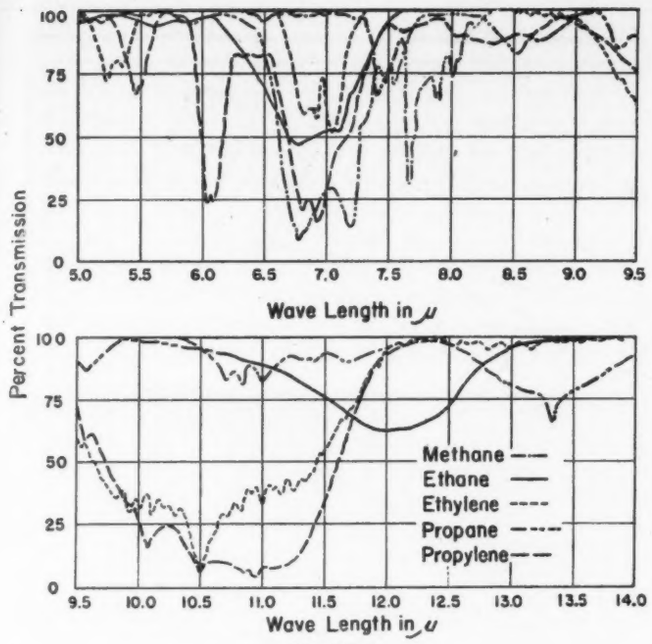



FIGURE 3

**Composite spectra of methane, ethane, ethylene, propane and propylene.**

monochromatic radiation the transmission of a single component can be written:

$$\frac{I}{I_o} = e^{-acx} \tag{1}$$

This expression is the familiar Beer's law, where $I_o$ is the incident energy, I the transmitted energy, $a$ the absorption coefficient, c the concentration and x the thickness of the absorbing layer. This expression can be put into the more familiar form:

$$\log_{10}\frac{I_o}{I} = \log_{10}\frac{1}{T} = \varepsilon cx \equiv D \tag{2}$$

where $\varepsilon$ is the extinction coefficient and D is the optical density. From these fundamental expressions it follows that, for monochromatic radiation, the transmission of a mixture is equal to the product of the transmissions of the components. Or, in the phraseology of equation (2), the optical density of a mixture is equal to the sum of the optical densities of the components. However, the transmission for a small wave-length interval, and not monochromatic radiation, is actually measured. The transmission of a mixture then ceases to be a simple function of the transmissions of the components.

Nevertheless, under certain conditions, a simple relationship between the transmission of a mixture and the transmissions of the components can be used. These conditions are:

1. That it is possible to find a wave-length interval, for each component, in which only this component absorbs strongly.

2. And that in this wave-length interval only the extinction coefficient of this principal absorber changes rapidly.

Under these conditions, it is assumed that the transmission of a mixture can be considered equal to the product of the transmissions of the components, to a sufficient accuracy for analysis of the mixture, despite the fact that the transmissions of the components are not given by equation (1).

The significant parts of the spectra of methane, ethane, ethylene, propane, and propylene are shown superimposed in Figure 3. On the basis of this figure, the spectral positions at which the transmission of a mixture would be determined and the principal absorber at each point are:

5.22μ — ethylene
6.05μ — propylene
7.68μ — methane
12.2μ — ethane
13.34μ — propane

In preparing for actual analysis of such a mixture the data represented by such a set of curves as Figure 4 are determined for each one of the above spectral positions. Figure 4 is a plot of the optical density against concentration in a constant length cell for each of the pure components. The unit of concentration used in this calibration chart is the concentration of gas represented by 1 mm. pressure at 25° C. As in the above simple case of butane mixtures, the

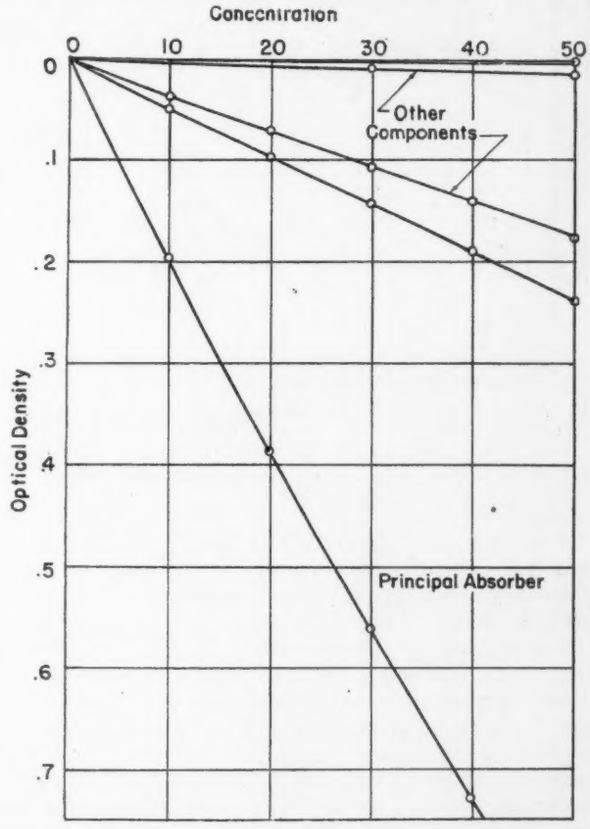



FIGURE 4

**Representative optical density—concentrated graph for a five-component mixture at one spectral position.**

spectral slit-width and the pressure (concentration) can be chosen so as to attain maximum analytical accuracy at each absorption position. Within the limits of usable energy traversing the spectrophotometer, this generally means narrow slit-widths and low pressures.

The actual analysis of such a five-component mixture would then be accomplished by determining the optical density of the mixture at the five selected spectral positions using the predetermined slit-widths and pressures. The concentration of each component is then determined by solving equations of the form:

$$D = d_1 + d_2 + d_3 + d_4 + d_5 \tag{3}$$

This equation restates that the optical density of the mixture is equal to the sum of optical densities of

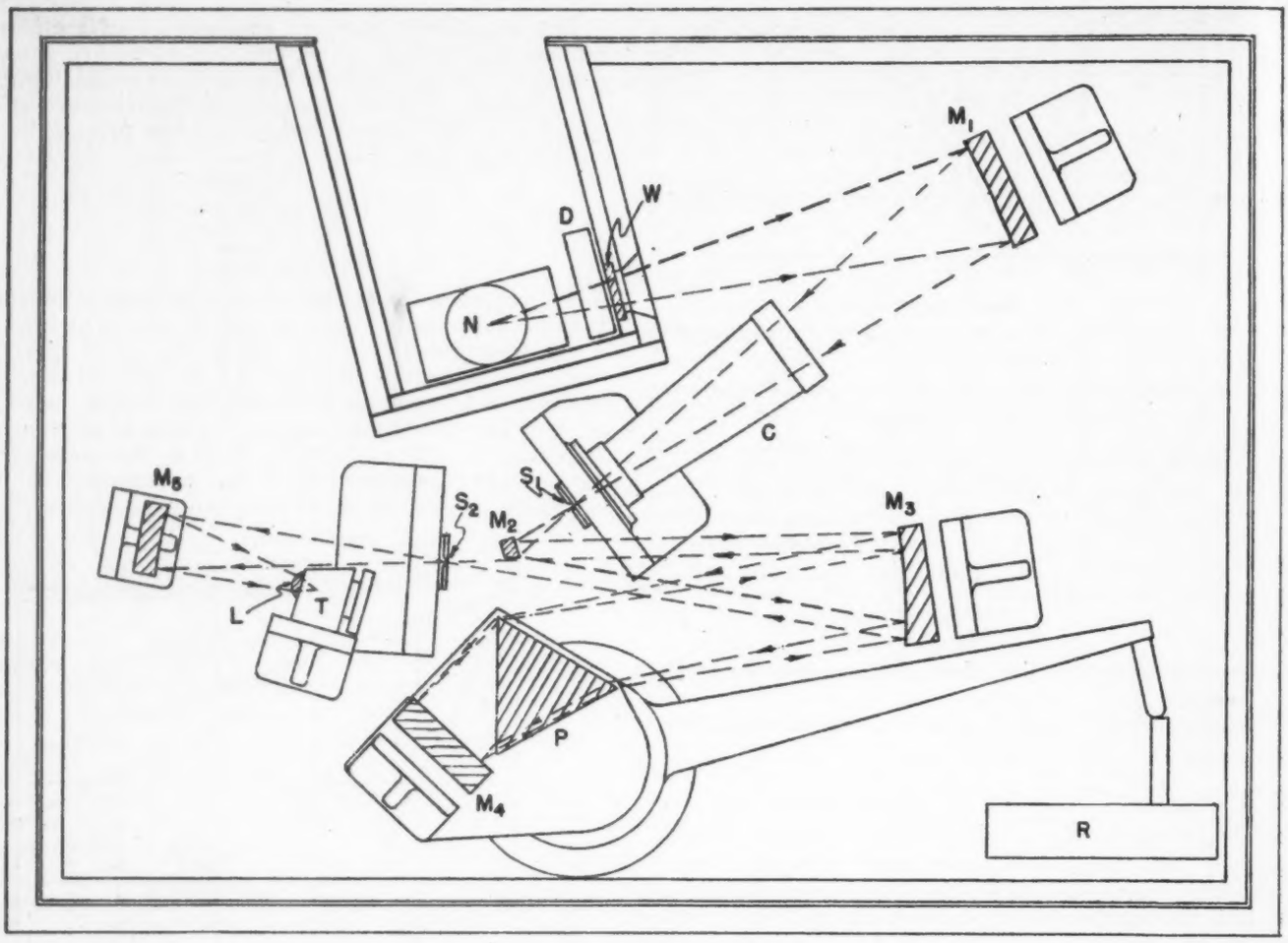



FIGURE 5
Light-path diagram of routine infra-red spectrophotometer.

the components. There is a similar equation for each spectral position—five in all. If the curves of optical density plotted against concentration (see Figure 4) are essentially straight lines, the concentrations of the components can be determined by simple linear equations derived from (3). If the above condition does not exist the concentrations can be determined by successive approximation. Although the latter system seems cumbersome, experience has shown that it can be completed in about 20 minutes for a five-component sample. This multi-component analytical procedure should give an accuracy of about $\pm$ 1.0 percent using the routine infra-red spectrophotometer described below.

### Routine Spectrophometer

As briefly mentioned earlier, the possibility of using infra-red spectroscopy as an analytical tool has long been recognized. The principal reason that development has been slow until recently is the difficulty of experimental technique in the infra-red. Briefly these difficulties arise from the necessity of using:

1. Prisms of sodium chloride, potassium bromide or lithium fluoride.

2. Thermopiles, radiometers, or bolometers as energy-measuring devices instead of photographic plates.

These difficulties have been overcome by gradual refinement over a period of years, until now it is possible to build an infra-red spectrophotometer which can be used for routine analysis in a plant-control laboratory.

The instrument described here is the third model of an infra-red spectrophotometer which was designed particularly for routine analysis. The original development was carried on at the Shell Development Laboratories and this work is being used as the foundation of the improved instrument now manufactured by National Technical Laboratories of South Pasadena, California.

The light path and the arrangement of parts are shown in Figure 5. The radiation from the Nernst glower source, N, enters the spectrophotometer case through the rock-salt window, W, and is focused by the spherical mirror $M_1$ at the first slit $S_1$. The sample cell, C, is attached to the frame of the first slit. The energy emerging from $S_1$ is reflected by the plane mirror $M_2$ onto the off-axis parabolic mirror $M_3$. $M_3$ is ground 14° off-axis and has a diameter of 4 cm. and a focal length of 20 cm. Since part of $M_3$ is not filled by the beam from $M_2$ the aperture of the instrument is about f6. The parallel beam from $M_3$ traverses the 60° rock-salt prism P twice, being returned almost on itself by the plane mirror $M_4$. The refracting faces of the prism are 4 cm. high and 6 cm. long. The dispersed beam returning from P is focused by $M_3$ onto the second slit, $S_2$, forming a spectrum in this plane. The radiation coming through $S_2$ is concentrated onto the receiving junctions of the vacuum thermopile, T, by the spherical mirror $M_5$

and the rock salt lens, L. The angular setting of the prism, and consequently the wave length of the radiation reaching the thermopile, is controlled by the stop mechanism, R. This mechanism is a turret rotatable from outside the case, which carries hardened steel pins adjusted to give desired spectral positions.

A water-cooled metal shutter and a diaphragm for regulating the energy entering the spectrophotometer are located at D. A shutter of lithium fluoride, for use at the longer wave lengths, and a magnesium oxide filter for eliminating visible radiation can be placed in the beam between W and $M_1$. The slits ($S_1$ is curved) are the bilateral parallelogram type and are both adjustable by the same control outside of the case. The entrance window, the prism, and the cell windows are protected from normal atmospheric water vapor by a thin coating of polystyrene. This is of use mainly during adjustment as the air inside the gas-tight, insulated steel cover is dried during operation. All parts are bolted and doweled to a heavy cast-iron base plate 22 x 16 inches. A view of the spectrophotometer is shown in Figure 6. The differential expansion mechanism, which rotates the parabolic mirror to compensate for the change in

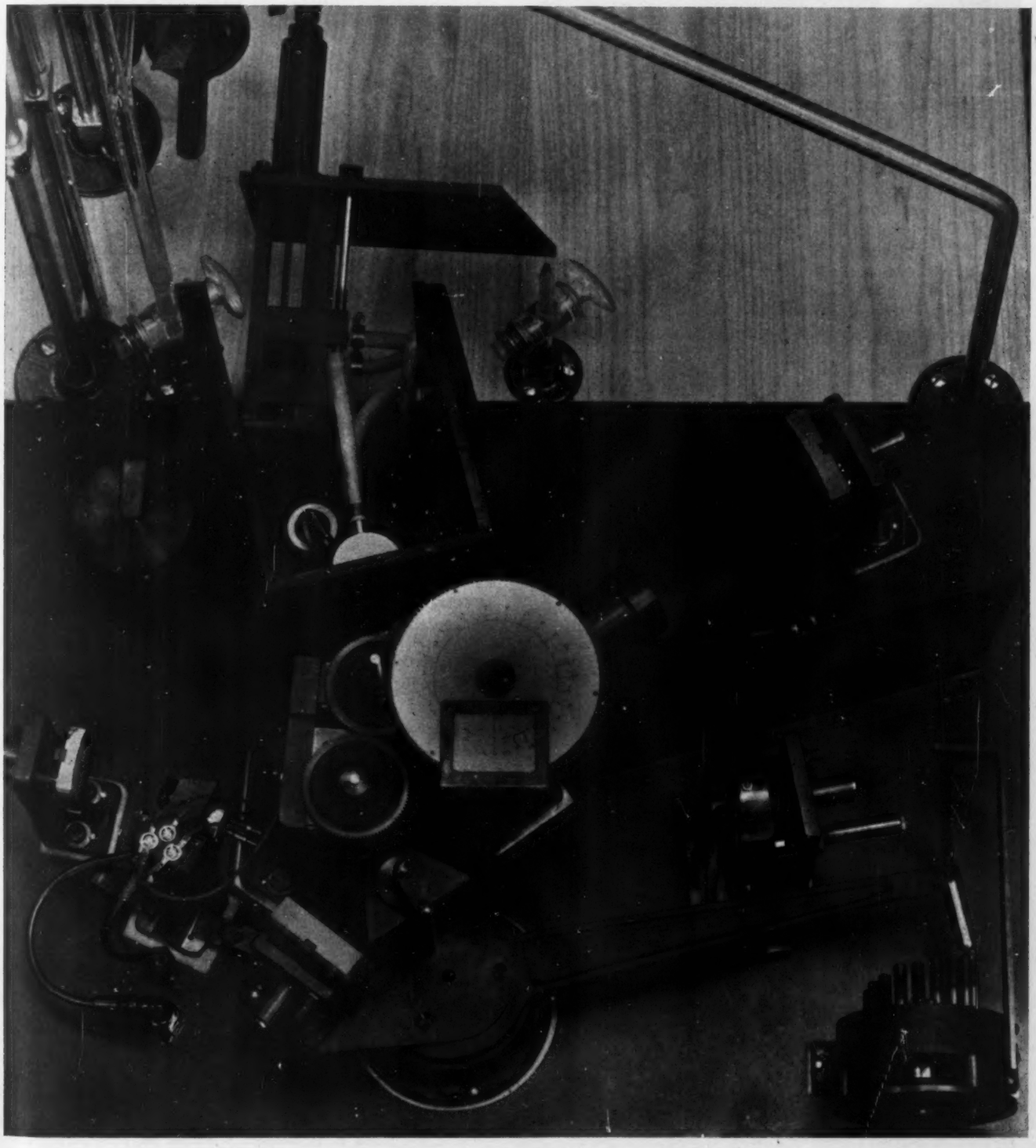


**FIGURE 6**
**Routine infra-red spectrophotometer (cover removed).**

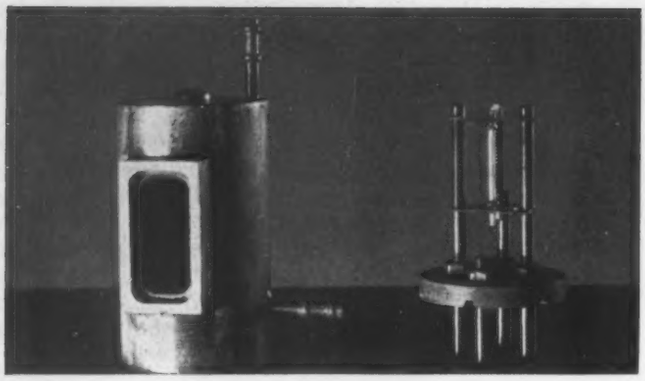


**FIGURE 7**
**Nernst glower radiation source**

refractive index of the prism with temperature, is visible on the back of the holder for $M_3$.

The parts of the special Nernst glower source are shown in Figure 7. The water jacket (6 cm. high) on the left is made from standard sizes of brass tubing. If the source is operated in a fire-restricted area, a rock-salt window is sealed into the recess in the flange. Under these conditions, the screw in the top can be removed periodically to replenish the air (oxygen) inside the jacket, which is necessary for maximum life of the glower. The right-hand view shows the Nernst glower and its starting heater assembled. The glower and the heater are located, with respect to the stainless-steel studs, by the two mica washers. The studs are spaced in the heat-resistant insulating disc so that they fit a standard four-pronged base. This disc for holding the studs also serves as the bottom end of the jacket. The assembled lamp on its base block is shown in the general view of a spectrophotometer given in Figure 6. All holes which affect the position of the Nernst glower with respect to the base block are jig drilled, allowing the source lamp to be replaced without readjusting any other parts of the spectrophotometer.

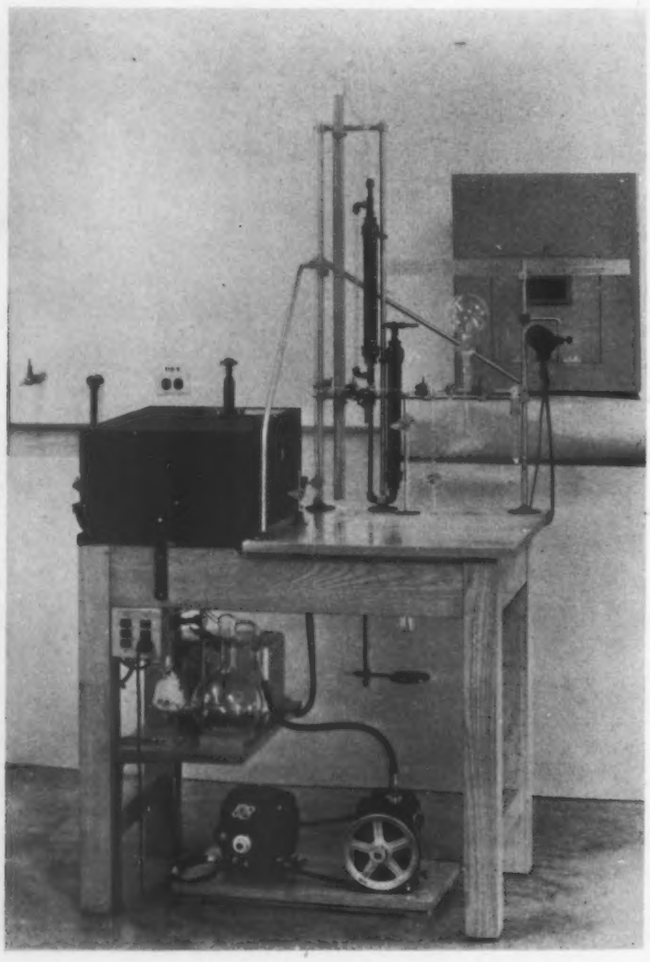


**FIGURE 8**
**Complete spectrophotometric analysis unit.**

The ballast resistance, the transformer for the heater and a relay are in a separate box. The circuit is such that closing the switch to 110 volts a.c. impresses the proper voltage across both the heater and the Nernst glower. As soon as the glower reaches the temperature at which it conducts appreciable current the relay shuts off the heater.

Due to the high operating temperature certain precautions in the construction of the internal parts are necessary. All studs, spacers, and nuts are made of stainless steel. The terminals are connected to the Nernst glower by the method described by Ebers and Nielsen[5] and the special heat-resistant wire, Kanthol A, is used for the heater.

A complete analysis unit is shown in Figure 8. The gas-handling system, on the right, is used to fill the absorption cell with a standard pressure of sample. Time is saved by sweeping the system with air between samples. The old sample plus the sweeping air is removed by an auxiliary vacuum line and the mechanical pump is used only to remove the remaining air. All controls, including the shutter valve, the galvanometer scale, and the source switch, are arranged so that they can be manipulated from the same position as the gas-handling system. The circuit for controlling the source is shown under the table in a separate gas-tight case. This gas-tight feature can be extended to the wiring so that the unit can be operated in fire-restricted areas.

The instrument as described is designed for analytical procedures based on the measurement of the absorption of gases between 2$\mu$ and 15$\mu$. However, neither the restriction to gas samples or to this spectral region is inherent in the design of the spectrophotometer. Substitution of a potassium bromide prism for the sodium chloride prism would permit work to about 25$\mu$ and substitution of a quartz or lithium fluoride prism would increase the resolving power at wave lengths shorter than 6$\mu$. A method for inserting liquid cells, such as those described by Gildart and Wright,[6] would make the analysis of liquid samples possible.

## Acknowledgments

The author wishes particularly to acknowledge his indebtedness to Dr. O. Beeck, who instigated and guides spectroscopic work at Shell Development Company, and to Dr. R. S. Rasmussen, the author's co-worker. Mr. H. H. Cary and Dr. A. O. Beckman have made major contributions to the design of the spectrophotometer and Dr. J. U. White of the Esso Laboratories and Dr. W. H. Avery of Shell Oil Company contributed helpful criticism and suggestions.

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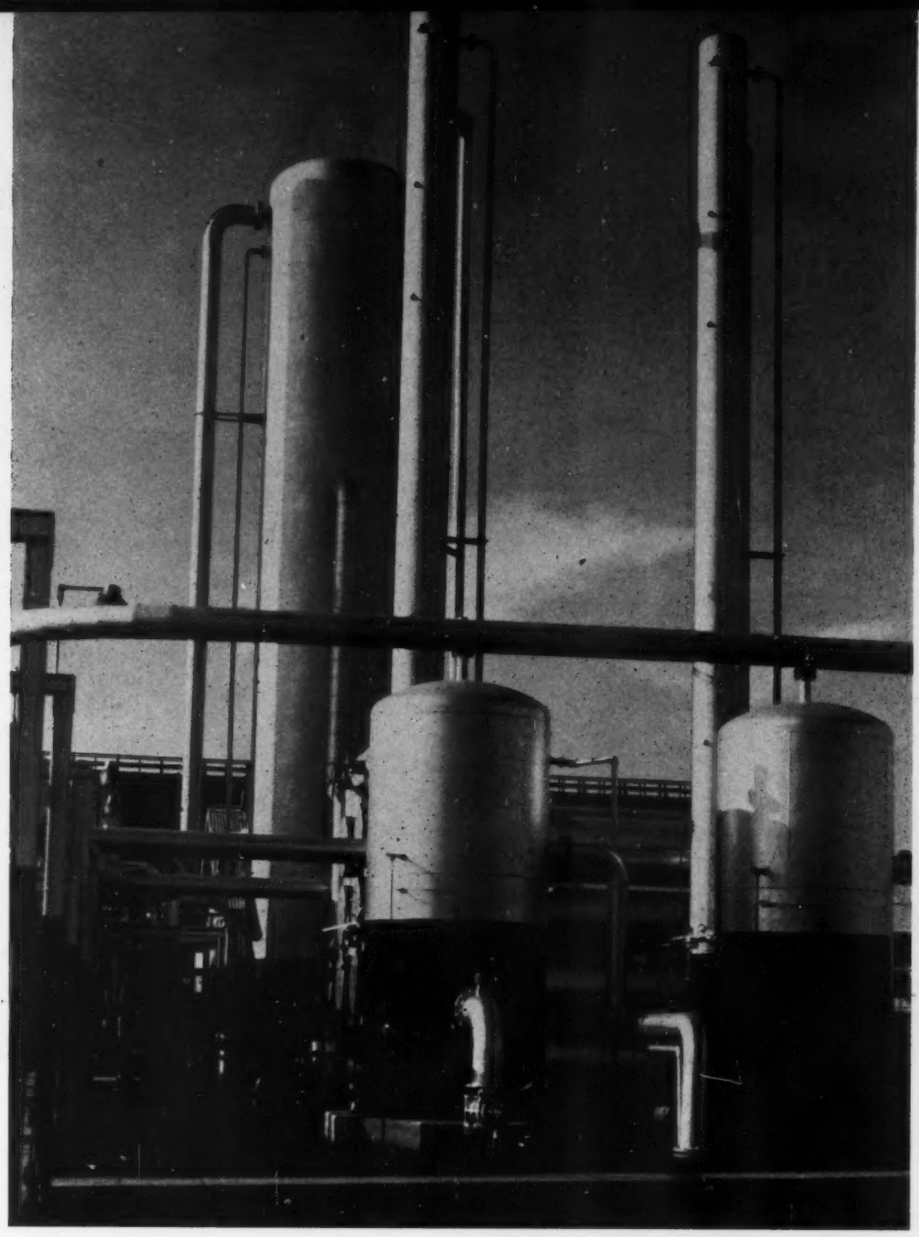


# Jal Plant Processes Two Grades of Field Gases

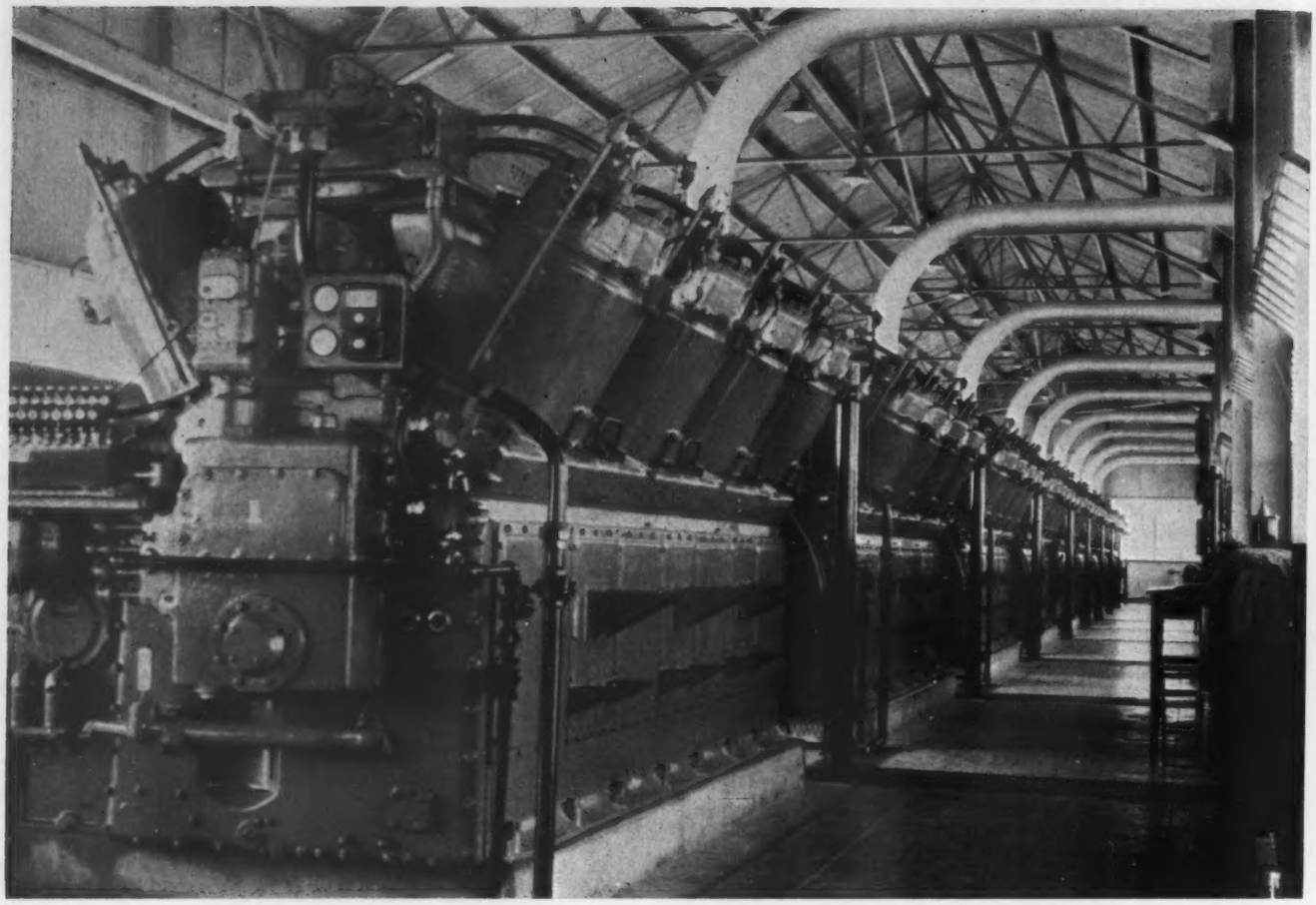
IN THE design of the absorption plant of El Paso Natural Gas Company, Jal, New Mexico, provision was made for handling the two types of field gases separately. This plant has access to both sweet and sour gases. Since the sweet gas can be delivered to pipe line connections without treating to domestic specifications, the gathering system as well as the absorber circuits were separated to permit separate processing.

After processing, the sour gas is returned to the field for pressure maintenance of the oil-producing formation. The plant requires 19 compressors, 17 of which are used for gathering field gases and bringing them to the plant absorption pressure, 70 pounds, while two are used for raising the dry sweet gas from 70 pounds to that of the domestic transmission line.

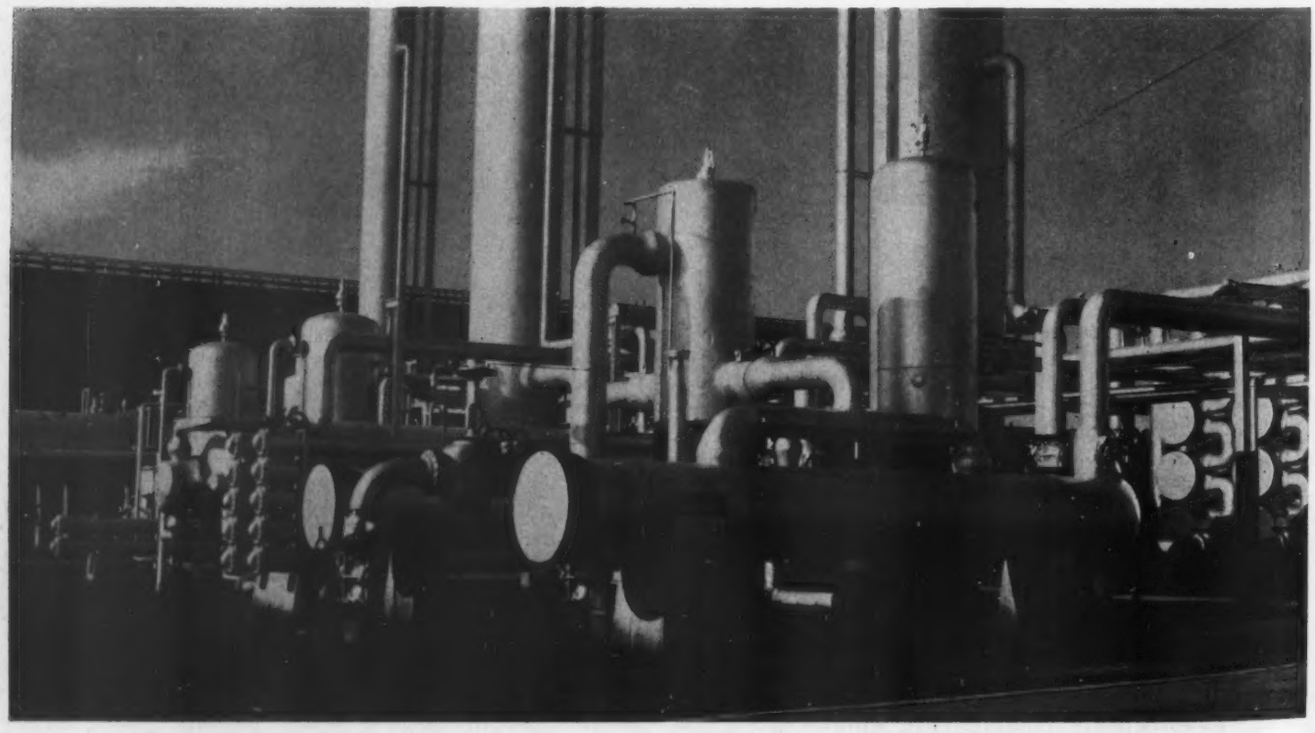
Three absorption columns are employed: 1 for sweet and 2 for sour. Approximately 1,500,000 gallons of 38-API-gravity, 410° F. initial boiling, 650° F. end point absorption oil are circulated daily through the processing of the plant by centrifugal pumps driven by steam turbines. Since atmospheric cooling is not sufficient for extraction of the extremely-low-boiling fractions in sufficient quantities, a propane chilling unit is incorporated in the oil circulation between the atmospheric water-cooled units and the absorbers. An average temperature of 59° F. is obtained on the lean oil by this method, which requires a 600-horsepower gas-engine-driven compressor operating at 60 pounds suction and 210-pound discharge through a closed system.

The enriched absorption oil is trapped from the base of the absorbers into a series of two pressure-reducing and venting systems. The first step is to 25 pounds and the second is to 9 pounds.

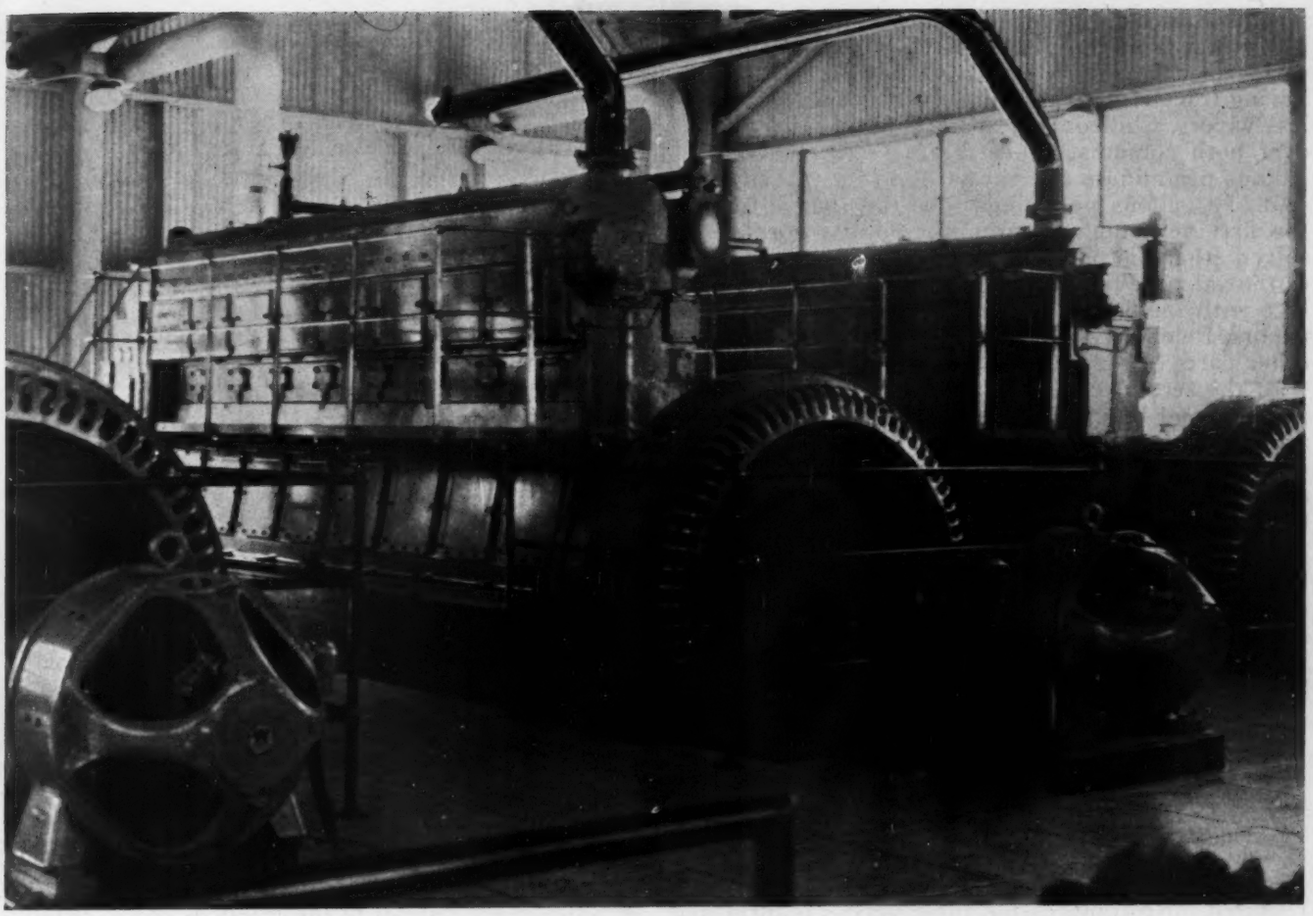
The function of these vent tanks, with their at-



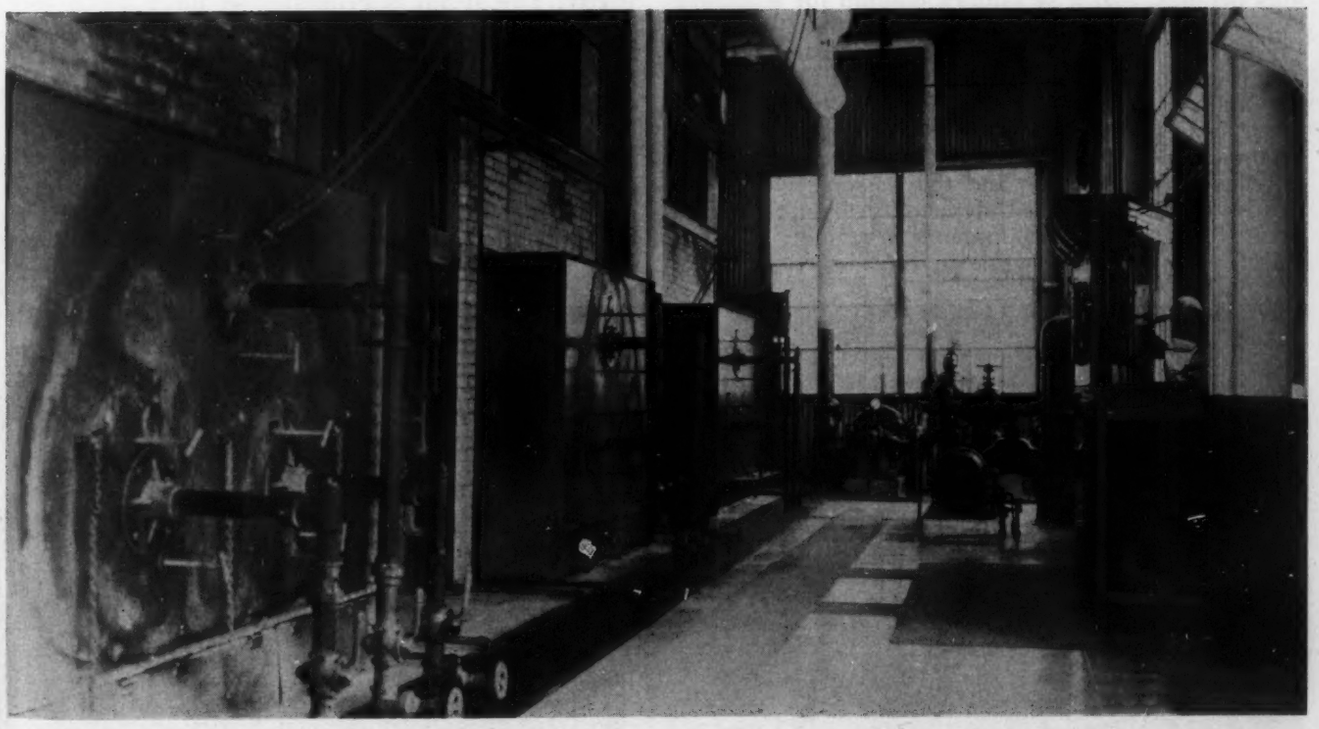
Two field gas systems are maintained by 17 gas-engine-driven compressors. Two other units deliver sweet gas to a domestic transmission system. Sour gas is returned to the field for pressure maintenance.



Propane chilling augments the cooling of the water system, being adapted to the oil system ahead of the absorbers.



Electric power is generated in the plant with three gas engines directly connected to generators.



The boiler plant carries a summer load of around 50,000 pounds of steam per hour and a winter peak of 66,000 pounds. Two of its three water-tube units care for steam requirements, leaving one for reserve. In addition to turbine-pump requirements, boilers provide process steam and winter heating. Raw water is treated for hardness and filtered ahead of make-up, 60 percent of which is from the well system and 40 percent from condensate return.

tendant vapor-absorbing columns, is to relieve the rich absorption oil of its dissolved low-boiling hydrocarbons, such as ethane, so that the still and the following fractionators will not be overloaded with useless vapors. Chilled, lean absorption oil is circulated over both columns; the first at a rate of about 10 gallons per minute and the second at a rate of from 15 to 20 gallons per minute. As the rich oil enters the first vent tank, a large percentage of the dissolved ethane is released, which carries with it some of the valuable fractions that are reabsorbed on contact with oil flowing counter current to the rising vapors. Released ethane is piped from the column to other parts of the plant.

In the second column, under still lower pressure, propane and butane have a tendency to escape, but are reabsorbed with the greater quantity of chilled oil so that, in the final analysis, little of the desirable fractions are allowed to escape. The reabsorbing volume of oil in each column passes down and into the stream of rich oil from the main absorbers and is carried with it to the distillation unit.

### Handling Vapors

Since the gasoline is partly stabilized in the absorbing oil, the raw product from the still is a product meeting pipe-line requirements, containing no lower-boiling fractions than propane. Vapors from the still pass through more or less conventional condensing equipment, but the uncondensed portion in the main accumulator drum, instead of being compressed and directed to a re-absorber, is totally condensed and tapped from the recompressor accumulator into the main stream of gasoline. The power required for recompressing these vapors is furnished by a 200-horsepower horizontal compressor operating at an excess of 150 pounds.

The stabilizing section consists of a main fractionating column having a capacity of about 140,000 gallons per day, and a secondary column for trimming liquefied petroleum gas to required vapor pressure. Production of conventional grades of natural gasoline is governed by the demand of purchasers, and the main column can be operated to produce any grade from 10- to 26-pound Reid vapor pressure. The production of liquefied gases is also governed by purchaser requirements and the seasons, with more or less propane included, depending upon the vapor pressure. If pipe-line shipments are made, the prestabilized commodity while in the absortion oil reduces the lower-boiling fractions to a point that no objections are offered to the product. When making commercial grades of the gasoline after stabilization is treated in a copper sweetening system.

**GAS ANALYSIS**

**Composite Wet Gas**

| Fraction | Volume Mol Percent |
|---|---|
| Carbon Dioxide | .90 |
| Nitrogen | .64 |
| Methane | 84.20 |
| Ethane | 6.81 |
| Propane | 3.73 |
| i-Butane | .61 |
| n-Butane | 1.29 |
| i-Pentane | .17 |
| n-Pentane | .72 |
| Hexane, Plus | .93 |
| | 100.00 |

**Gasoline**

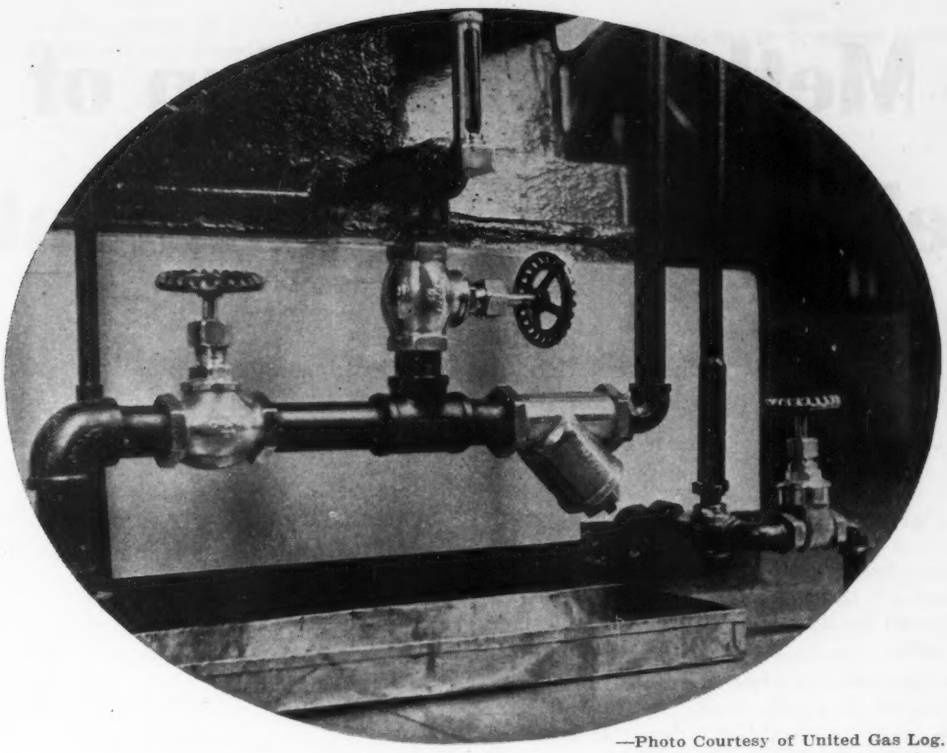
| Fraction | Gas Volume, Mol Percent | Liquid Volume |
|---|---|---|
| Propane | 1.40 | 1.00 |
| i-Butane | 4.00 | 3.60 |
| n-Butane | 27.30 | 23.20 |
| i-Pentane | 12.90 | 12.80 |
| n-Pentane | 16.80 | 16.60 |
| Hexane Plus | 37.60 | 42.80 |
| | 100.00 | 100.00 |

**Residue Gas**

| Fraction | Mol Percent |
|---|---|
| Carbon Dioxide | 0.70 |
| Nitrogen | 1.14 |
| Methane | 85.30 |
| Ethane | 8.06 |
| Propane | 4.05 |
| i-Butane | 0.33 |
| n-Butane | 0.34 |
| Pentane Plus | 0.08 |
| | 100.00 |

Power for plant operating is basically gas engines. Pumps for circulation are driven by steam or electricity. The steam is generated in three water tube boilers with the make-up feed consisting of condensation and raw water, treated to control total hardness. Electricity is generated by three vertical gas engines connected to alternators. Propane for filling the chilling system is produced from the butane fractionator to exclude butane from the stream. Since the absorption oil is stabilized through the double drop venting system, ethane and lighter is eliminated so that weathering of the propane is unnecessary before it is pumped into the chilling system.

Gas coolers on the engine discharge.



—Photo Courtesy of United Gas Log.

# Redesign Improves Splash-Type Lubricating System

BY REDESIGNING the oil leads and adding a by-pass to the splash-type lubrication system for internal-combustion engines, effectiveness of lubricant has been accomplished in compressor stations of United Gas Corporation. The revised layout permits recirculation of fluid as well as counter-current drainage to remove sludge without dismantling lines. The design further permits cleaning of the sight glass without disconnecting the lines.

The lubricant, pumped from the crankcase sump throuh a filter by the usual gear unit, is carried to the elevated leads to the main rod bearings through the usual riser. This fluid under pressure is filtered through the usual unit, and then passed through a second supplemental unit in the horizontal run just before the tie-in of the riser. This second strainer is designed to catch only those particles of carbon and lint which bypass the main strainer, and serves to protect the settings of the needle valves which regulate distribution to the individual oil leads.

By bringing this return lead below the level of the crankcase base, the line carrying the usual sump sight gauge is extended to overhang the horizontal oil line, being tied to it with tee and valve so that, if desired, the entire circulation of the pump or any desired portion of it may be returned directly to the sump, thus permitting a quicker cycle of oil through the filter than would be the case where the flow was all carried through the riser and distributed over the bearings.

The tie-in of the line to the lower side of the run to the gauge glass also permits the entire contents of the sump to be drained through this nipple, into the horizontal line, and out through the section filled with the screen unit when it is in place. This reverse flow through the line enables the short horizontal runs to be flushed thoroughly of carbon and other sediment, and is a marked improvement over the plan whereby the gauge is carried at the end of a dead line, in which flow through the crankcase sump tends to cause the accumulation of dirt, eventually causing incorrect oil level to appear on the glass.

A further gain through the use of the set-up shown lies in the ease with which the sight glass can be cleaned without dismantling. The cap can be removed at the top of the glass, and the unit cleaned with a kerosine- or gasoline-soaked swab with the valve below in the open position. Any possible contamination of the sump oil is thus avoided, the cleaning fluid draining down into the run and thence into the screen trap.

Placing a shallow pan, of galvanized metal or painted to insure visibility of oil leak, permits the system to be drained without marring or spotting the floor, and enables the tightness of oil-line joints to be verified simply by inspecting the condition of the inside of the bottom of the pan.

# Method of Design of Steel Stacks and Foundation

SAMUEL LEVINE
Director, Manhattan Technical Institute

IN POWER plant engineering, the design of stack and foundation is a problem which can be solved by elementary structural principles. The work may be greatly simplified by the use of tables and approximations, which will in no way reduce the practicability of the results.

After the mechanical engineer has determined the diameter and height of stack, a survey of the site, and borings are made to establish allowable bearing capacity of the soil, and investigation made of wind velocity. Following that, the design procedure could methodically follow a number of steps.

In order to illustrate the principles and methods of design, it is advisable to apply them to a practical problem which the author had occasion to work on recently. In this problem the given data were:

Maximum wind velocity = 100 m.p.h.
Allowable soil pressure = 2500 p.s.f.
Stack diameter = 7 feet.
Stack height = 100 feet.
Figure 1 shows the stack and foundation.
Table 1 gives areas and moments of inertia for octagonal footings which are most commonly used for steel stacks.

The steps in the design procedure are as follows:

A. The wind pressure (p) on the stack surface may be computed from the wind velocity.

Wind pressure, $p = 2/3\ (.004)V^2$
V = wind velocity (m.p.h.) = 100
$p = 2/3\ (.004)\ (100^2) = 27$ p.s.f.

B. The wind load (P) on the surface of the stack is equal to:

$P = pDH$
$= 27\ (7)\ (100) = 18{,}900$ pounds.

This force is considered to act at the midpoint of the stack as shown in Figure 1.

C. This wind load causes an overturning moment (Mo) which is:

Mo = Ph, where h = length of lever arm to the footing base.
$= 18{,}900 \times 62.5 = 1{,}185{,}000$ foot pounds.

D. Before we can determine the moment of stability, we must estimate the weight of the stack and foundation. This necessitates that we design the shell thickness and estimate the foundation area.

The shell thickness is determined by investigating the moments at elevation 0′-0″ and at elevation 15′-0″. (See Figure 1.)

$Mo\text{-}o = 18{,}900 \times 50 \times 12$ inch pounds.

The resistance to this moment determines the shell thickness. From the well known flexure formula, $\frac{M}{S} = \frac{I}{C}$, using an allowable stress of 12,000 p.s.i. for steel we get

$$\frac{I}{C} = \frac{945{,}000 \times 12}{12{,}000} = 945$$

Now the standard formulas for $\frac{I}{C}$ (section modulus of a ring is: (See Figure 2.)

$$\frac{I}{C} = \frac{.0491\ (D^4 - d^4)}{D/2} = \frac{.0982\ (D^2 + d^2)\ (D + d)\ (D - d)}{D}$$

This lends itself to a practical simplification, if we substitute:

$D^2 + d^2 = 2D^2$ (very nearly)
$D - d = 2t$
$D + d = 2D$ (very nearly)

The resulting formula becomes

$$\frac{I}{C} = .7854\ D^2t$$

(Note: D is expressed in inches in this formula.)

$$\text{Therefore, } t = \frac{945}{.7854\ (11 \times 12)^2} = .07''$$

An investigation into the required thickness at elevation 15 feet, where the stack diameter narrows down to 7 feet, shows that it will be less than ¼ inch. We may therefore safely use a ¼-inch plate thickness for the entire height of stack.

Now, to estimate the total weight of stack and foundation, we assume an octagonal footing, L = 20 (see table) and proceed as follows, referring to Figure 1, and Table 1:

| | |
|---|---|
| Weight of Stack = 3.14 (7) (100) (10.2) = | 22,000 lbs. |
| (1 sq. ft. or ¼″ steel plate weighs 10.2 lbs.) | |
| Weight of Collar = 3.14 (11.7) (1.5) (10.6) (150) = | 88,000 lbs. |
| Weight of Brick = 3.14 (8.7) (15) (4/12) (125) = | 17,000 lbs. |
| Weight of Fill = 7.6 (332-140) 80 = | 117,000 lbs. |
| Weight of Footing = 332 (2) (150) = | 100,000 lbs. |
| Total Weight | 344,000 lbs. |

Therefore, the Moment of Stability,

$Ms = 344{,}000 \times 10 = 3{,}440{,}000$ foot pounds.

E. The factor of safety against overturning will be

$$\frac{Ms}{Mo} = \frac{3{,}440{,}000}{1{,}185{,}000} = 2.9$$

This indicates that the stack is stable against overturning.

F. Soil pressures may now be investigated to see if the allowable 2500 p.s.i. is exceeded.

| | | Maximum | Minimum |
|---|---|---|---|
| $\frac{P}{A} = \frac{3,440,000}{332}$ | = | 1035 lbs. | 1035 lbs. |
| $\frac{MC}{I} = \frac{1,185,000 \times 10}{8800}$ | = | 1348 lbs. | — 1348 lbs. |
| Totals | = | 2383 lbs. | — 313 lbs. |

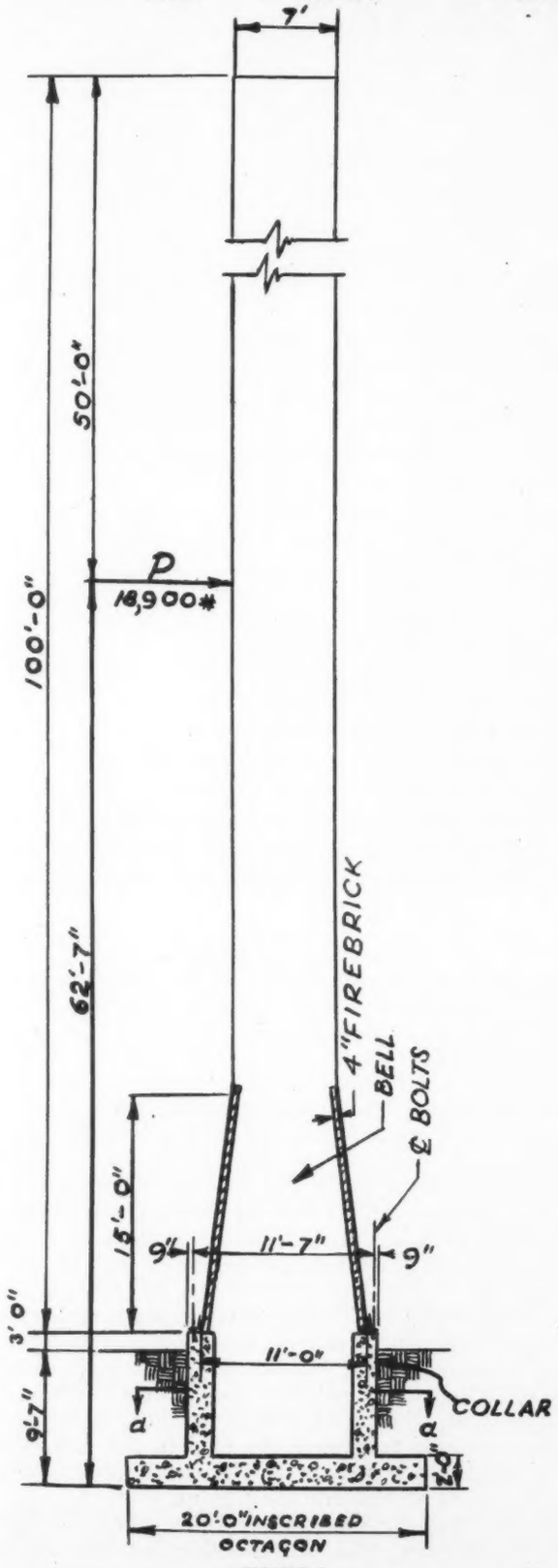
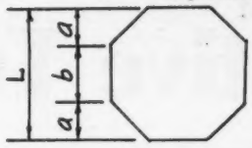



FIGURE 1

**TABLE 1**
**Properties of Octagonal Footings**

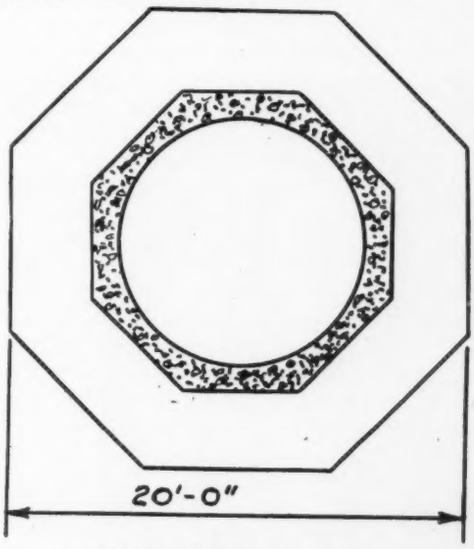



L = Inscribed Diameter
A = 0.83L²
I = 0.055L⁴
a = .293L
b = .414L

| L, Feet | A, Sq. Ft. | I, Feet⁴ | L⁴ | a | b |
|---|---|---|---|---|---|
| 10 | 83.00 | 550.0 | 10000 | 2′ 11 1/16″ | 4′ 1 3/4″ |
| 11 | 100.4 | 805.2 | 14640 | 3′ 2 11/16″ | 4′ 6 5/8″ |
| 12 | 119.5 | 1141 | 20730 | 3′ 6 5/16″ | 4′ 11 5/8″ |
| 13 | 140.3 | 1571 | 28560 | 3′ 9 15/16″ | 5′ 4 5/8″ |
| 14 | 162.7 | 2113 | 38420 | 4′ 1 5/8″ | 5′ 9 5/8″ |
| 15 | 186.8 | 2784 | 50620 | 4′ 4 3/4″ | 6′ 2 1/2″ |
| 16 | 212.5 | 3604 | 65530 | 4′ 8 1/4″ | 6′ 7 1/2″ |
| 17 | 239.9 | 4594 | 83520 | 4′ 11 3/4″ | 7′ 0 1/2″ |
| 18 | 268.9 | 5773 | 105000 | 5′ 3 1/4″ | 7′ 5 1/2″ |
| 19 | 299.6 | 7167 | 130300 | 5′ 6 3/4″ | 7′ 10 1/2″ |
| 20 | 332.0 | 8800 | 160000 | 5′ 10 1/4″ | 8′ 3 3/8″ |
| 21 | 366.1 | 10700 | 194500 | 6′ 1 1/4″ | 8′ 8 3/8″ |
| 22 | 401.7 | 12890 | 234300 | 6′ 5 1/4″ | 9′ 1 3/4″ |
| 23 | 439.1 | 15390 | 279900 | 6′ 8 11/16″ | 9′ 6 3/4″ |
| 24 | 478.1 | 18250 | 331800 | 7′ 0 3/16″ | 9′ 11 3/4″ |
| 25 | 518.7 | 21480 | 390600 | 7′ 3 7/8″ | 10′ 4 3/4″ |

This shows that the maximum soil pressure is not exceeded and the design is both stable and safe.

The design of the reinforcing steel for the footing, and the bolts are now a matter of the application of standard formulas and tables.




SECTION a-a

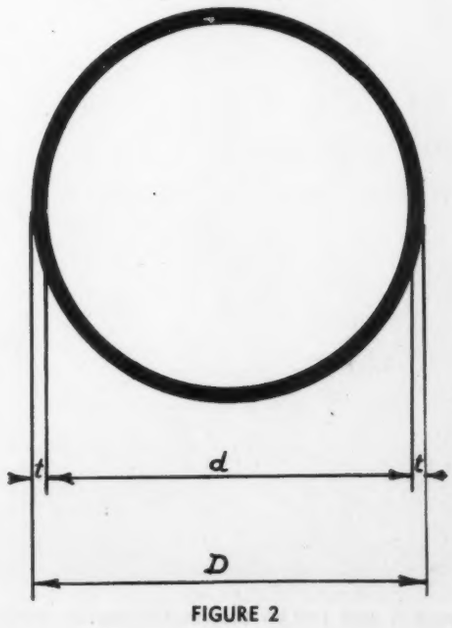
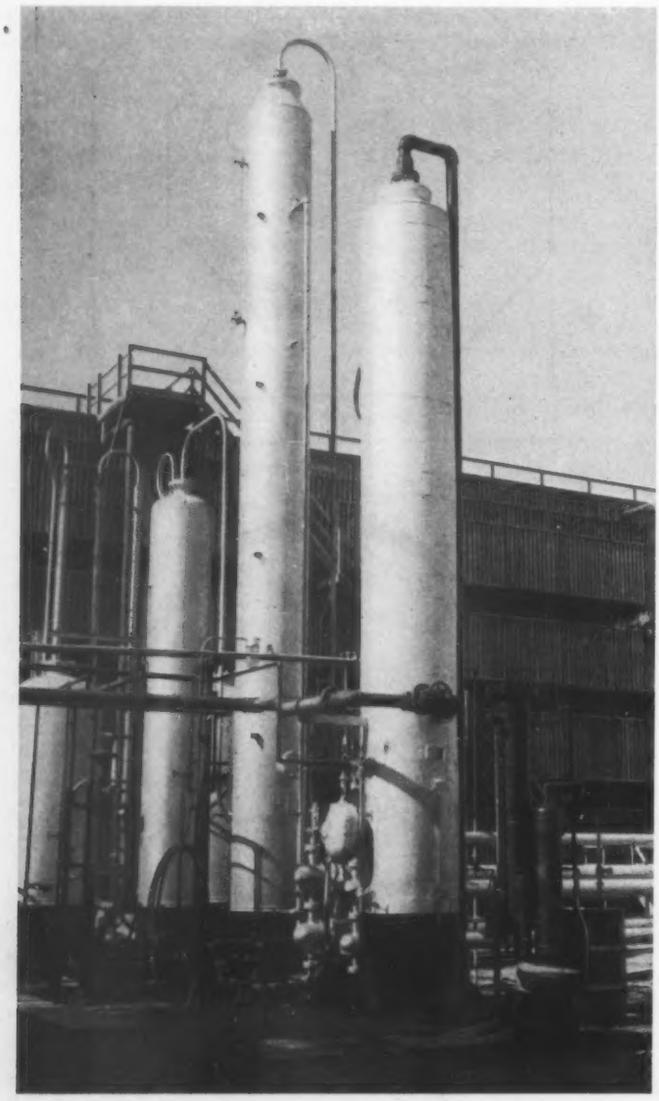



FIGURE 2

# Effective Treating for a Small Plant

SOLUTION of treating problems in the small refining plant are difficult to accomplish for the reason that research and laboratory facilities are not comparable with those of the larger plants. The method used in one of the small plants of the West Coast came into use through trial-and-error progress so that now caustic washing of cracked distillate is employed in two stages, the first for the removal of $H_2S$ and the reduction of mercaptan content in the second.



Caustic is used first on the cracked pressure distillate.

The caustic solution of this second stage also serves to wash the vapor charge to the polymerization plant for $H_2S$ reduction.

The plant output is doctor sweetened. The treating method is of continuous operation with treating solutions regenerated.

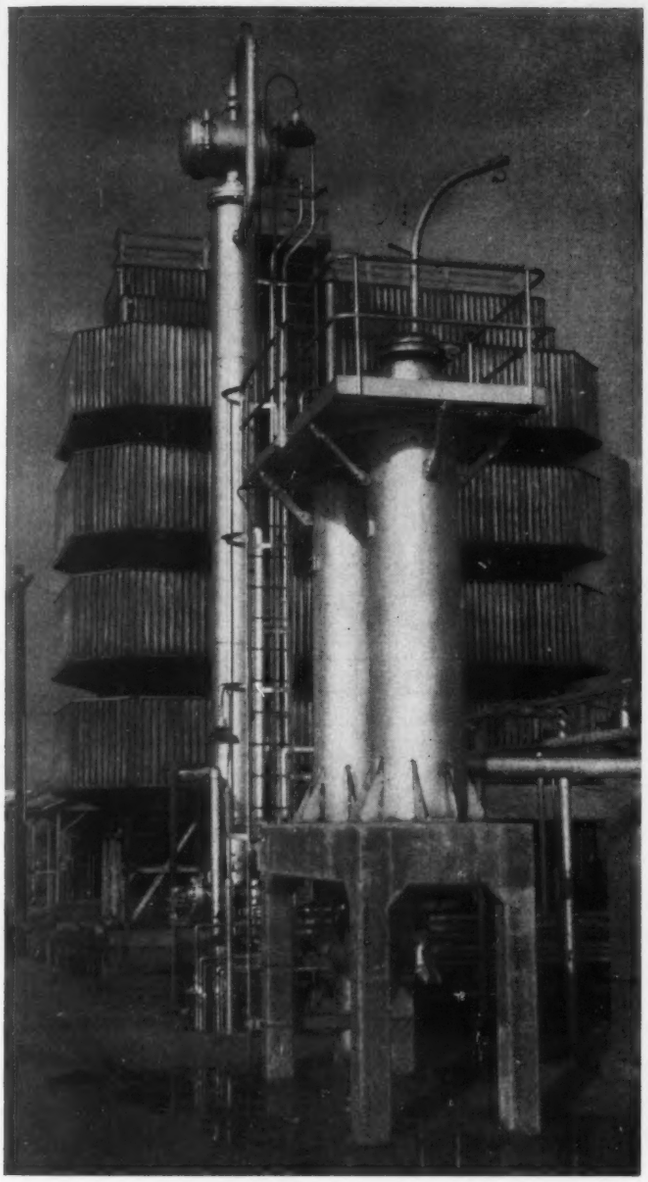
Distillate from the cracking plant rerun section which is used for the control of the end point of the cracked gasoline, is passed through a vertical column filled with carbon rings and containing an aggregate of 10 barrels of 15° Be. NaCl solution. A second column serves as a separator to retain any solution which may pass over with the gasoline as suspended matter. Mercaptan reduction is obtained with a continuous regenerative system having a contactor and a mercaptan-removal column, both containing 10 barrels of 22° Be. NaCl solution in the aggregate.

The solution is pumped from the contact column through heat interchangers and a steam-heated preheater to the mercaptan removing column, or that which is more commonly called the caustic regenerating tower. Caustic entering the regenerator is held at a temperature of 238° F., which separates practically all of the mercaptides which leave the column through a 4-inch pipe connected to the breeching of the cracking furnaces for burning.

The stripped solution flows back from the column through the heat interchangers and through a water-cooled unit to bring the temperature down to 90° F., because it has been found that this gasoline is more easily treated when the caustic is at 90° F.

Since this cracked gasoline contains phenols, the NaCl solution in both contactors absorb it from the distillate, which, after a concentration above a certain percentage, ordinarily around 32 percent in the mercaptan system, tends to release it back into the gasoline. The rate of absorption is not so rapid in the $H_2S$ system as in the mercaptan solution, but after approximately 7 days of treating, the $H_2S$ caustic must be evacuated from the system in order to protect to some degree, the purity of the caustic employed to reduce the mercaptans. Regardless of the caution employed in the treating plant, the rate of phenol absorption in the mercaptan-removal solution averages about 1 percent per hour. Because of this condition, the solution in the regeneration system is dumped each 24 hours into the contacting system employed to reduce the $H_2S$ in the vapors handled by the compressor at the catalytic-polymerization section of the cracking plant.

Treating is continuous in all phases of this section of the refinery, and the gasoline leaving the mercaptan column flows directly to the doctor con-

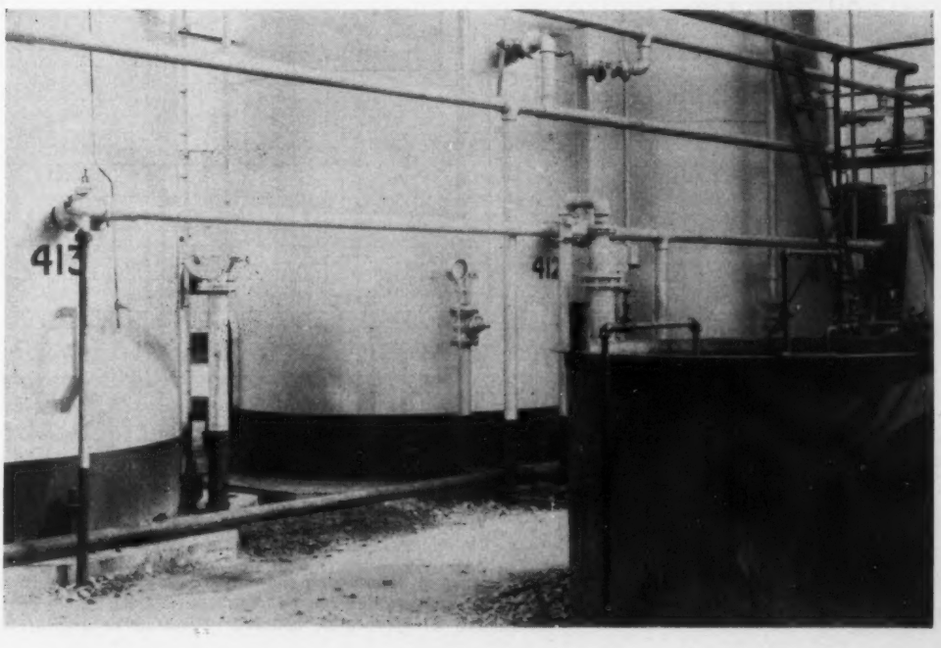


Before gases from the cracking plant enter the polymerization unit, they are treated with the caustic, which previously contacted the pressure distillate.

tactors. Doctor is pumped to the gasoline stream which enters apparatus designed to provide maximum turbulence and minuteness of contact, with both streams entering a series of two horizontal separating drums. Gasoline emerges from the top of the first to pass to the second and to storage.

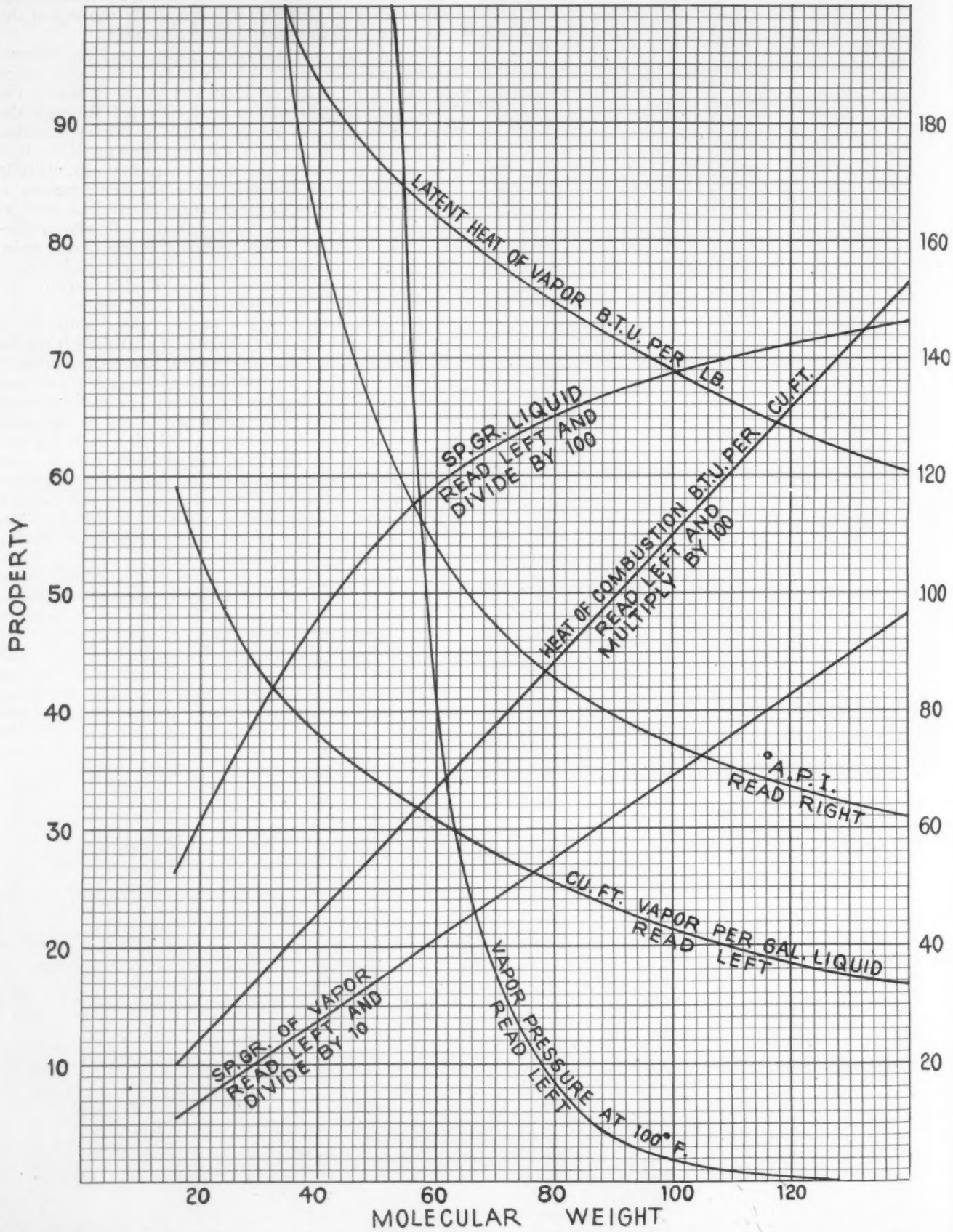
The doctor regeneration unit contains reserve storage vessels to hold both spent and regenerated chemicals, and two cone-bottom tanks in which the doctor solution is heated and recycled through the aerator column. When a charge of doctor solution has been used in contact with cracked gasoline, it is pumped into one of the cone-bottom tanks, usually amounting to 88 barrels. Here the temperature is raised gradually with steam coils in pancake form at the neck of the cone, and a second coil, also a pancake arrangement a foot below the top of the solution level. Both coils are controlled independently of each other so that heat can be applied in varying degree and intensity where it is most needed. After bringing the temperature of the spent solution to 195/200 F., circulation is begun by pumping from the outlet connection manifold at the base of the cone to a column made of a full joint of 15-inch pipe, containing adequate baffles for mixing the solution with air. The manifold at the point where the doctor solution and air are mixed has a third pipe carrying saturated steam so that the temperature can be controlled, and water added in the form of steam condensate if advisable. Recirculation is continued for approximately eight hours with air injected in the manifold at the base of the aerator and both leaving to return to the cone-bottom tank.

The amount of gasoline accompanying the doctor solution is so small that it is not economical to install a recovery system. But the presence of gasoline in the doctor causes foaming at certain periods of regeneration which is retarded and eliminated with heat from the upper pancake coil just below the top of the liquid in the cone-bottom tanks. Releasing steam in controlled amounts through the top pancake coil quickly evaporates the small amount of hydrocarbons in the emulsion, and has worked satisfactorily for the prevention of boiling over.

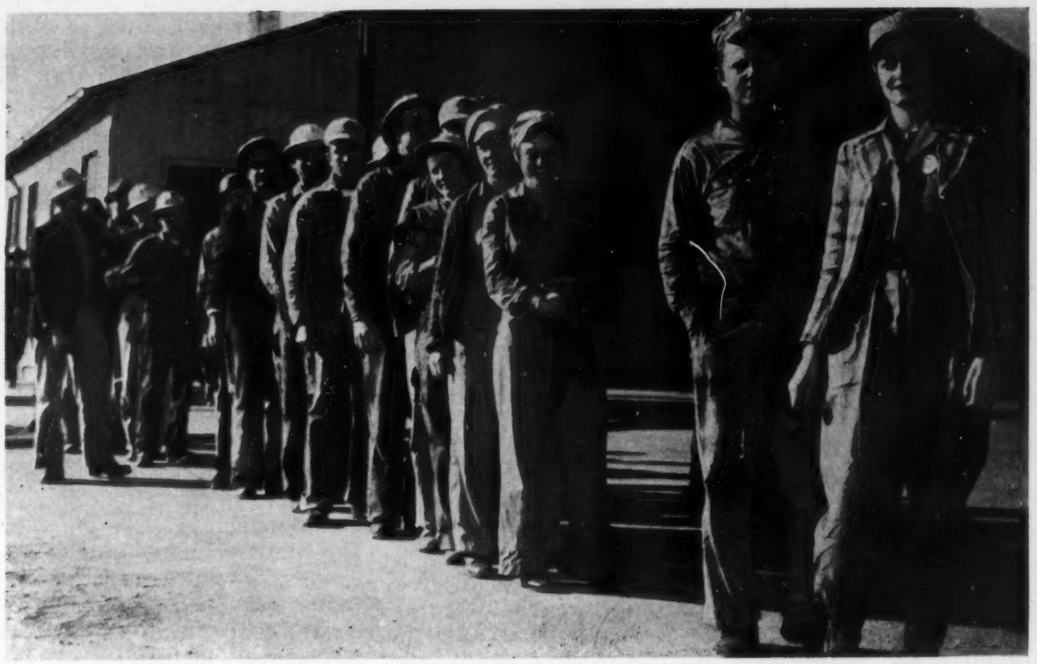



Nozzles, valves and gauging apparatus in the caustic-treating unit.

# Properties of Normal Paraffin Hydrocarbons




The above curves are convenient for the designer in determining the approximate properties of a hydrocarbon mixture. If one of these properties can be determined or calculated other properties can be obtained from the curve. These curves are not applicable to a mixture containing an appreciable quantity of isomers or unsaturates.



Photograph, courtesy Shell Oil Company.

# Inducting Women Into Industry

LORETTA MOUSHEY
Assistant Director, Industrial Relations Section, Monsanto Chemical Company

**LIKE the chemical industry, petroleum refining now faces the necessity of adapting women to much of its plant work. Consequently this estimate of the problem and its solution by the assistant director of the industrial relations section of Monsanto Chemical Company is reproduced from the February issue of the Executives Service Bulletin of the Metropolitan Life Insurance Company.**

**Personnel departments of most of the larger refining companies are learning from experience part of what has been learned in this instance.**

**Later *Petroleum Refiner* will offer another article on the experiences of one of the larger refining companies in training women for plant duties.**

IN THESE times, with industry working at top speed to convert to the manufacture of new products needed in the conduct of the war, with the effort accompanied by increasing demands all along the line, and with manpower shortages becoming in consequence more and more acute, employers are turning to their only point of relief—the employment of women to take up some of the burden.

In plants and laboratories in which women have been employed for years, there are no new problems arising from the increase in the number of women to be employed. However, in those plants and laboratories which have been exclusively man's territory, there are a great many problems that must be solved *before* the first women goes to work, and there are equally as many problems that will develop *after* the first woman has gone to work.

For one reason or other, some of the industrialists who have for years been operating in a man's world do not welcome the thought of the employment of women.

It is possible that women who are engaged in the field of industrial relations are prejudiced in favor of their sex, but the fact does remain that men who have for months sidestepped the use of women in industry or research, and then were forced into it because they could obtain no other employes, have become the strongest proponents of women in industry.

The company with which I am associated and the industry of which it is a part have been a man's world. With a few minor exceptions, most of our work has been closed to any but men, and a great many other industries have had a like policy. As a result of the war emergency, Monsanto Chemical Company has converted from all-man operations to the use of both sexes in a great many different fields of endeavor. Our experience in this connection is set down here not as expert advice for those who have

employed women for years, but merely an exposition of that experience.

Placing of women in the plants has been a transition, but a gradual one. In November, 1941, we began to realize that eventually we would have a manpower shortage. If we were to be faced with the problem of losing some of our operators, we knew we had better move fast and work out a practical plan for replacement.

### "Pre-Manning" Survey

Long before the Manning Plan was introduced, we began a survey of our many plants to establish some basis for computing our male losses. This survey included each man's name, draft status, and a description of his job. The jobs were then classified under Class 1—Most desirable for women; Class 2—Desirable only for certain types of women. Some departments were made suitable for women by assigning a few Gallahads for the heavier work of lifting or trucking.

We considered factors such as cleaness of the job, strength required, fatigue, companions, hazards, hours, whether or not the work was hard on the hands and complexion. We transferred men from light work which could easily be handled by a woman into heavier jobs which were more difficult for the new feminine contingent. We investigated state and federal laws concerning hours that women were permitted to work and the facilities they required.

Our physical examinations for women are rigid, and reexaminations at specified intervals are compulsory.

After putting a lot of thought and planning into making our plants as desirable as possible by installing restrooms and smoking rooms, individual showers and lockers, we felt that it was only fair to hire women who were in all respects desirable to us. I am not trying to infer that we are limiting our requirements to artists' models. But we did want clean, wholesome, and intelligent women to fill this temporary breach—and we so proceeded.

A program of supervisory training is well under way. We wanted our supervisory staff to realize the necessity of bringing women into the operations, also the necessity of making them feel as though they were really helpers and not just nuisances. We are attempting to point out to our supervisors some of the differences between men and women, such as their temperament, their more easily hurt feelings, and their slower grasp of mechanics.

We emphasize rigid safety training programs for women. I was recently told by Dr. E. R. A. Merewether, His Majesty's Inspector of Factories in Great Britain, that in England in 1941 the adult female accident rate per 1000 workers was slightly more than three times greater than the adult male rate. We may equal this in the United States, but we certainly hope not to surpass it.

In the Monsanto plants, from the standpoints of safety and comfort, women are required to wear slacks, despite the fact that all of us at some time or other have been faced by an apparition weighing about 165 pounds, clothed in male attire. This may not be a sight that we long to contemplate, but we feel that we have covered the situation in an attractive way.

We designed a slack suit with safety cuffs on the trousers and an over-blouse, rather than the tuck-in blouse which is so attractive on bantams. The blouse has a slightly flared peplum effect at the bottom which fits well down over the hips and is becoming to both large and small types. Narrow red binding edges the collar and cuffs, and a Monsanto insignia on the pocket furnishes a feminine touch. The outfit is topped off with a jaunty peaked cap which has a side corner for an identification button to perch as an ornament instead of just a number.

### Red, White and—Khaki

The slack suits are made in three colors—white for laboratory, blue for mechanical departments, and khaki for the operating departments. In laboratories and drafting rooms the same jacket is worn, but a slightly gored skirt is substituted for the slacks.

As to the type of work done, at this time women in our plants are handling only those jobs which require short training periods. However, their quickness to learn, their adaptability, and their versatility lead us to believe that they will go far.

In machine shops they handle drills, lathes, and routine machine-shop work. In some units they check scales, operate control boards, acquire knowledge of materials such as correct moisture content, study analyses, turn valves, operate loading machinery, direct crane operations, watch temperatures and pressures, weigh materials, sew and label bags and containers, cap drums, draw samples for analyses, and drive intra-plant trucks.

Also, in one of our plants women operate a water-filtering unit capable of supplying water to a city of 20,000 persons. All water used in the plant is purified, and the whole filtering plant operation has been turned over to women. They run comparative tests on the water, open and close valves, start and set filters, and inspect settling basins. Part of this job is the daily climbing of a 75-foot safety-cage ladder that goes to the top of a million-gallon tank.

In the laboratories women handle routine analyses and prepare and distribute samples.

### Testing a Theory

Our senior planning engineer, H. S. Morse, had a theory that untrained girls with some knowledge of art work would make good draftsmen. Given carte blanche, he hired a group of girls from an art school and went to work. With less than a year's training they have become familiar with surveyor's instruments, and have mapped out all the intricate system of pipe lines in a plant which is one of the largest chemical producing units in the United States. If a sketch of an operation is needed, they go out and make it. They no longer wonder whether calipers are something you eat or wear. They have reached a point where they rate as junior engineers.

Our gradual conversion to the use of women in a variety of assignments convinces us—and I am expressing here not my opinion but that of our operating managers, department superintendents, personnel managers, and safety engineers—that women will be an integral and highly valued personnel group in Monsanto's operations before many more months have passed.

When we started out in our planning more than a year ago, the one central thought that guided us was to "determine those jobs in each plant which women can handle."

It is now quite evident that we put the cart before the horse. If we were to do it again we would "determine those jobs which women cannot handle," because we have found there are very few duties for which they cannot be considered.

# Caustic in Vapor Stream Halts Corrosion

WHEN excessive corrosion was found in the vapor line from the dephlegmator and in condensers in one of the West Coast natural gasoline plants, investigation established that the cause was acidity in the vapor stream and its resulting condensate.

The fact that in refining it is common practice to introduce alkaline solutions into vapor lines at many points, was in part responsible for the selection of a caustic injection as a means of neutralizing the destruction of sulphur compounds in this instance.

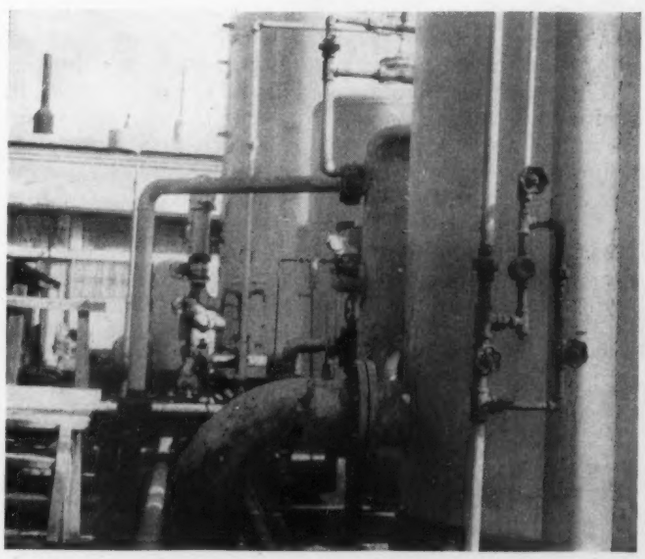
The major problem was in the method introducing the solution. Because of the lack of desirable equipment, such as a proportioning pump or other force feed appliance, recourse was taken to the method used in plants involving a blow-case, such as is seen in refineries manufacturing various grades of distillates and lubricating stocks. The system should, obviously be as simply made as practicable so that workers not familiar with gasoline-plant operation who might replace those inducted into the armed forces, might readily grasp the significance of the process and operate it without involved calculations and frequent manual manipulation.

The steaming down of solid NaOH has always been a simple procedure requiring only the use of a vessel to receive the solution after the chemical is removed from the light-weight metallic drum, and the necessary steam and water lines and fittings to service the reduction unit. A conventional receiving tank was fitted with the connections for handling the solution, and set on a stand placed over a concrete cradle poured to support the blow case. A moveable gin-pole was set beside the unit having a cross arm for connecting the chain hoist with which the full drum of solid caustic is handled. The blow-case itself is a pressure vessel converted to its present use from a tank employed as a small capacity oil and gas separator. The original openings were closed by welding and the needed connections attached for filling, venting and releasing the solution to the point of use.

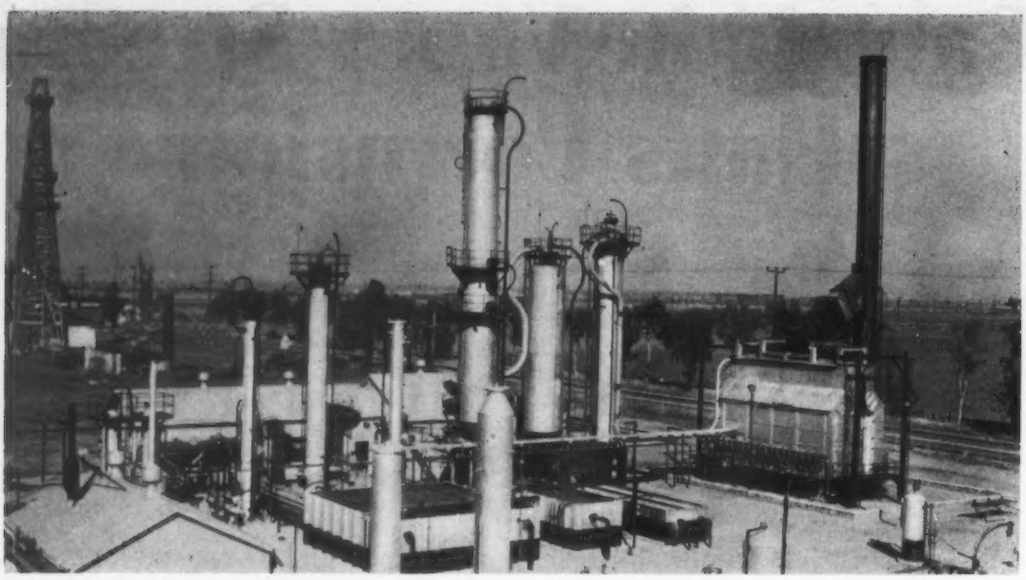
This blow-case was installed horizontally with the sludge drain at the bottom at one end, which is slightly lower than the opposite one, so sediment can be blown into the sewer lines. A gauge glass assembly was attached to the end facing toward the controls so that the quantity of the solution might be visibly checked both during operation and when refilling with a freshly liquefied batch of solid NaOH. This vessel is protected also with a safety relief valve to automatically vent excess pressure should the reducing instrument admit a greater amount of air than required.

A connection was made in the vapor line in the horizontal section after it leaves the top of the distillation equipment and starts on its horizontal run toward the cooling tower and the condenser sections. The tap was made in the top side of the piping, using a two-inch collar for the fittings, reduced immediately to one-inch with a control gate valve fitted on the reducer to shut off the treating line when necessary to recondition or maintain the equipment. A one-inch line connects with the base of the blow-case at the higher end and is led beneath the soil to a point just below the two-inch tap on the vapor line. The required fittings for breaking out the one-inch line and connecting the injection equipment were placed in the vertical section of the one-inch line at a height convenient for an employe to observe and control the process. On either side of a control gate valve in the vertical section is a tee for connecting the by-pass which carries the metering instrument for caustic injection.

The apparatus for actually controlling the flow of caustic to the feed line is a small sight feed lubricator-type instrument having an orifice inserted which was selected to deliver the necessary amount of solution under the plant operating pressure. The blow case is fitted with a connection passing through a pressure reducing and controlling instrument which admits air under pressure to the vessel so that a constant head is maintained above the pressure of the vapor line leading to the gasoline condensers. Should the orifice or instrument become clogged with sediment, undissolved caustic sludge or precipitated chemicals, a secondary line is utilized, attached to the manifold and sight-feed instrument for blowing under pressure to clean the orifice and fittings. Inspection of the vapor line, the condensers and analysis of the water from the accumulator tank indicated that the corrosion of equipment has been arrested. The treating plant, once filled with the required strength caustic solution operates for several days without attention by the plant operators. Only occasional inspection of the liquid level and the drop by drop of the solution flowing through the sight-feed indicator is made by the employes of this gasoline plant.



**Sight feed indicator with which the amount of injection caustic is determined in drops per given unit of time, with by-pass pressure line attached at top of instrument for venting and removing accumulated sludge.**



# Polymerization Unit Converted To Depropanizing Column

WHEN cracking-still gases became more desirable as alkylation-plant feed than for conversion to polymer gasoline, one refinery on the West Coast converted its polymerization unit into a depropanizing column. As such it is operated to provide part of the raw charge for alkylate which goes into high-octane-aviation gasoline.

Instead of having polymer product for blending into its own motor-fuel output, the company is having a part in the war products program of the area.

The cracking plant stabilizer is so operated as to remove all butane and thus assure all unsurates and isobutane for alkylate. Removal of these light ends reduces the vapor pressure of the stabilized gasoline and raises its initial-boiling point. This deep cut into the distillate also leaves propane in the gases and this must be removed before the desirable fractions are delivered to the alkylation unit. In turn the depropanized product is refractionated previous to going into alkylation feed, so the normal butane can be returned to the refining plant, where it is used to blend back with the cracked gasoline for front-end control.

In normal times providing for removal of propane from a vapor would involve no more than buying and erecting the equipment. Shortage of steel, however, offered no prospect of early addition of facilities for providing the proper alkylate feed to the aviation-gasoline plant. It was then that the polymerization unit was considered in the light of conversion to another type of processing. Conversion was simple, since it involved but little more than shutting down the catalytic operation and changing to conventional depropanizing practice, employing hot fractionation of propane from the vapors instead of from a liquid charge.

At first the poly stabilizer was operated without internal changes as a depropanizing column but this was not successful. This vessel was equipped with Raschig rings to about half its length instead of buttle trays and this did not provide sufficient contract surface. Additional rings were added almost to the intake of the reflux nozzle, after which equilibrium was established and satisfactory propane removal resulted.

The shift in operation was made when catalyst was almost spent. These columns were emptied, cleaned and left in the line, hooked in series flow so no additional piping would be required for by-passing. The compressor which served as poly feed, still picks up vapors from the pressure-distillate stabilizer and receiving drum and feeds them through the poly heater and into the converted fractionating column.

The caustic-treating plant, between compressor and fractionator, was left in operation so as to remove $H_2S$ from the depropanized product, which must be sweet and non-corrosive as alkylate feed.

Since nothing was removed from the polymerization unit when conversion was made, it can be returned to making polymer gasoline with little effort when conditions warrant.

Output of this unit goes to the aviation-gasoline plant by truck and the normal butane is returned by that means.

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4 Spacing band centers glass and prevents contact with metal.

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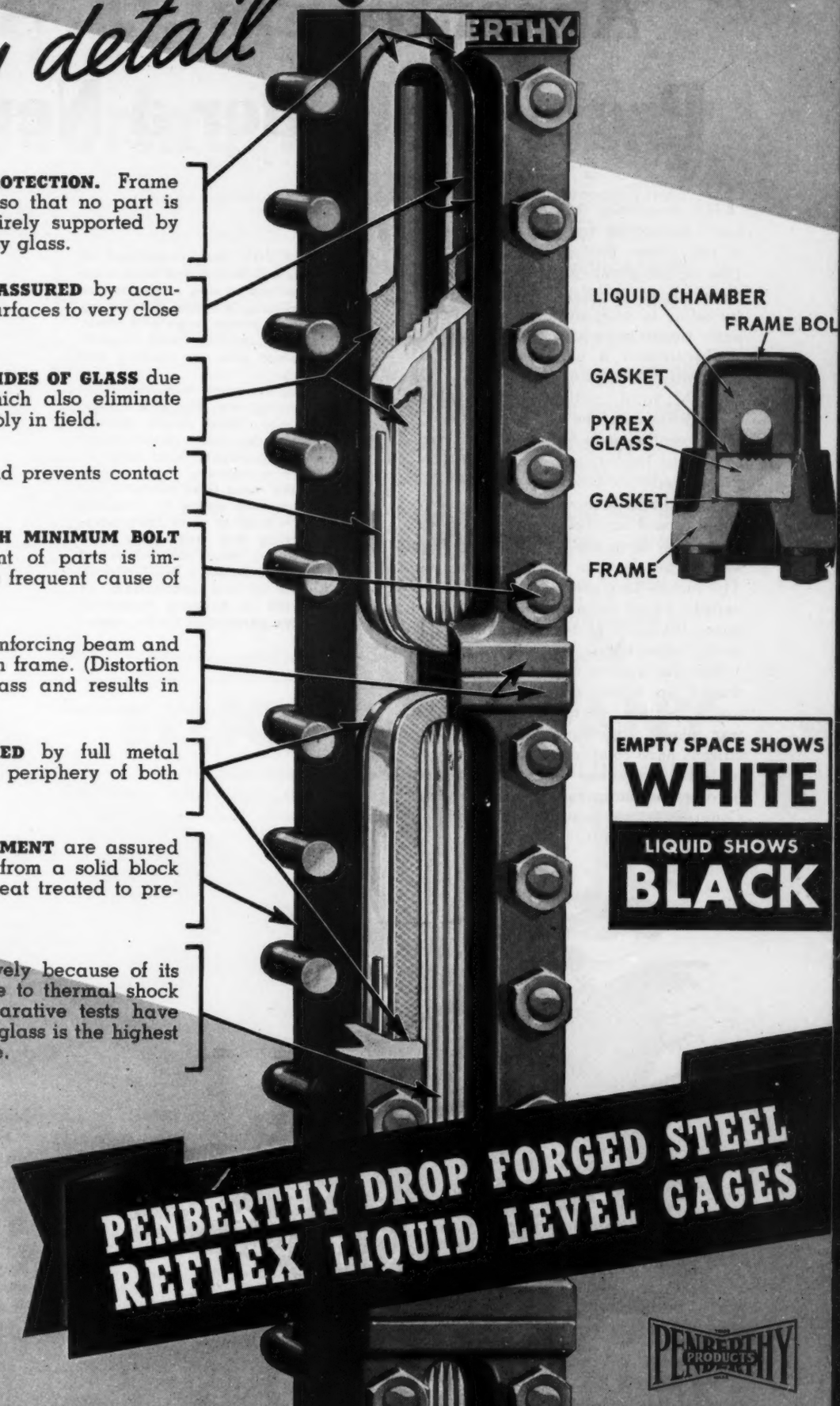


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# Absenteeism . . . An Old Problem Under a New Name

THE staggering loss of time in manhours has grown to serious proportions in war plants throughout the country. Like a cancerous growth gnawing at the vitals of industrial production it is spreading to such an extent that it seriously threatens to affect our war effort.

Absenteeism is not a new word. It has long been recognized as a good English word which lexicographers have defined as one who absents himself from his post. Absenteeism in various forms has existed to a nominal degree in industry for many years.

With the sudden expansion of industry to speed up the production of war materials, there has followed too high an increase in time lost from the job. The causes have also become many and varied. All of them are now described under the more or less dormant, single word, "absenteeism."

The war against absenteeism is being waged on a nation-wide scale by a major portion of the large industrial war plants. Statesmen, officials, and citizens have condemned and denounced it, but it continues to increase. It has become so widespread that the national Congress is now considering legislation designed to curb it.

**ALTHOUGH the information on which this article is based came from the operations of one of the larger refining plants, it bears definite relationship to plants large and small. Management can see itself, regardless of plant size, by reading and comparing.**

**It is worth noting that absenteeism is nothing new, also that it consists of more than simply staying away from the job without cause. Illness and accidents loom large in any effort to improve plant output. It will take more than patriotic appeal to increase output by inducing men and women to work more days.**

**The article was written by Norman D'Olive, associate editor of "The Humble Refinery Bee," March, 1943, one of the publications of Humble Oil & Refining Company, which gave permission for its reproduction.**

Experts are devoting considerable study and attention to its causes and how to prevent it. The reasons for absenteeism are many. They have been classified as unavoidable, preventable, and inexcusable. Regardless of the classification and the causes, the effects of absenteeism inevitably result in loss of time from the job. This loss of time in manhours provides revealing statistics that tax the imagination.

To bring the full import of lost manhours to the attention of war workers, many comparative figures have been presented. We hear and see these figures at every hand. To the average person they are no doubt interesting. But too many of us are prone to regard them with passive interest. We even talk about them and deplore them, but, like the weather, we are not inclined to do much about it, individually.

Individually, however, we can do much to eliminate absenteeism. Every employe contributes to the absenteeism problem when he loses time from the job. Every hour or minute lost, whether justified or not, represents valuable time that cannot be reclaimed, for there is no substitute for time.

Bringing it right down to our own essential job of producing aviation gasolines, fuels, toluene and other war materials, we, as Humble employes, have an absentee problem which merits serious consideration.

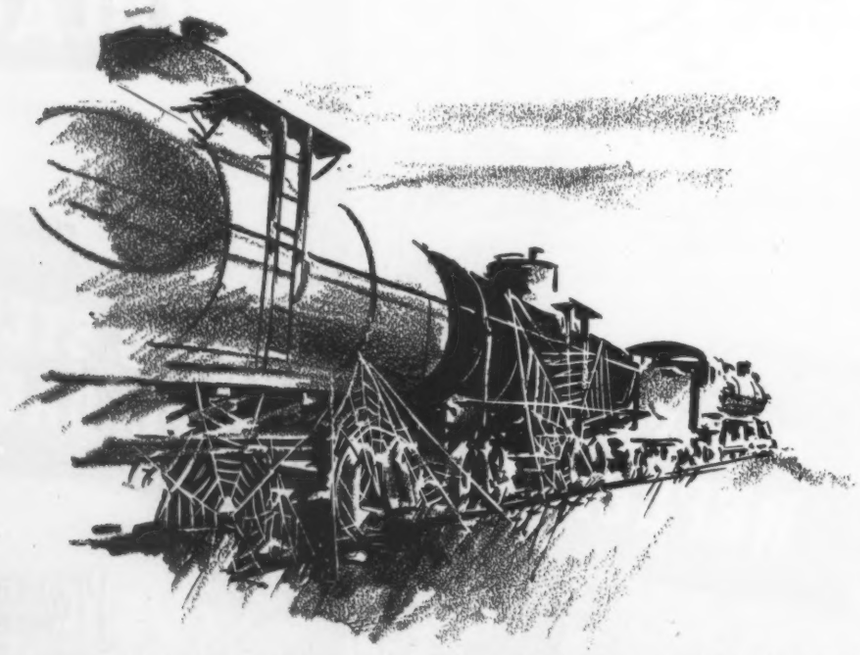
For instance, illness took a toll of 224,000 manhours (approximately) among Humble employes at Baytown last year. Serious illness and accidents have been classified as unavoidable. Minor illness and avoidable accidents are classified as preventable.

Approximately 50 percent of the total time lost by Baytown employes on account of illness was due to respiratory ailments, such as chest colds, sinus trouble, tonsilitis, flu, bronchitis, laryngitis, ear infections, et cetera. With proper precautions, most of these ailments can be avoided.

Stomach disorders caused approximately 20 percent of the time lost due to illness. Proper dieting and precautionary measures can avert this type of illness.

Severe changes in weather and failure to wear proper clothing caused impairment of health to such an extent that considerable time was lost from the job.

Another source of physical impairment is the emotional factor, or unnecessary and excessive worry. This is especially prevalent under wartime conditions such as we are now experiencing. Worry over financial, marital, and



**If the amount of time lost at Baytown refinery last year had been concentrated in the railroad department, it would have paralyzed our transportation of essential war products for two-and-a-half years.**

# *Mystery of the* disappearing tube cleaner

In one of the larger middle west refineries, among their tube cleaners they have (or had at the time) only one of the new Elliott-Lagonda 1100 Series motors, with double ball-thrust bearings. When it came time to clean a still, this particular cleaner would invariably be missing, but would miraculously reappear when actual cleaning started. It seemed that one of the operators, seeking the advantage of the superior speed and driving power of the Elliott cleaner, privately "borrowed" it and hid it, making sure that with it he would lead the field in the cleaning job. Whatever you may think of the ethics of this performance on the part of the operator, there can be no two opinions as to the performance of Elliott-Lagonda 1100 Series motors. It **IS** good.

## ELLIOTT COMPANY

*Tube Cleaner Department,* **SPRINGFIELD, OHIO**

*DISTRICT OFFICES IN PRINCIPAL CITIES*

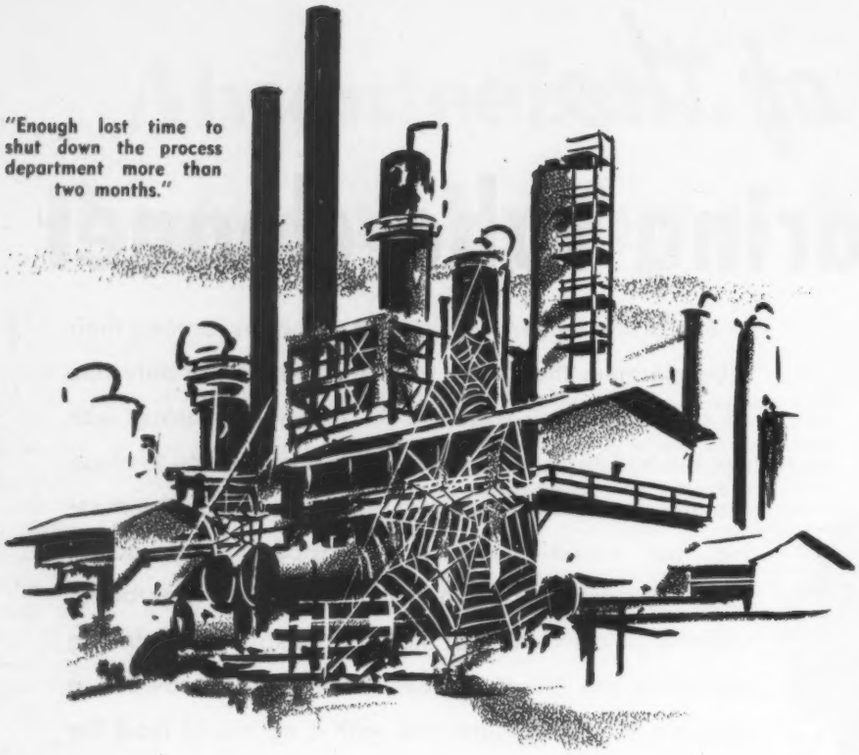
## BALL-THRUST BEARINGS

at both ends give this Elliott 1100 Series tube cleaner motor freedom from rotor drag, putting practically all the power into the important job of biting out coke. The result is they go through coked-up tubes sometimes in half the time formerly needed. The ball bearings prevent all tendency to bind with either the "pull" of a self-feeding cutter head, or the "push" of the operator feeding into heavy coke.

**There's a bulletin out on this new cleaner, and it gives some pretty interesting data. Write for copy.**

Y-194

## ELLIOTT *Lagonda type* TUBE CLEANERS



"Enough lost time to shut down the process department more than two months."

job problems, anxiety over the war, causes shocks to the nervous system that produce telling effects on employes. A few fundamental rules, if closely observed, will materially reduce illness and the resulting loss of time from the job; namely, proper diet, rest, mental diversion, clothing, and exercise. If we will make a strong effort to keep a proper balance in our habits and activities, we can maintain a higher standard of health and strengthen our morale.

Disabling injuries on and off the job also exacted too high a toll among Humble people at Baytown last year. Nearly 65,000 manhours were lost due to industrial accidents. The time lost due to off-the-job accidents, more than 156,000 manhours, convincingly indicates that it is far out of proportion to our record for safety on the job. However, we cannot ignore the fact that time lost due to industrial and non-industrial injuries kept employes from a vital war industry more than 220,000 manhours.*

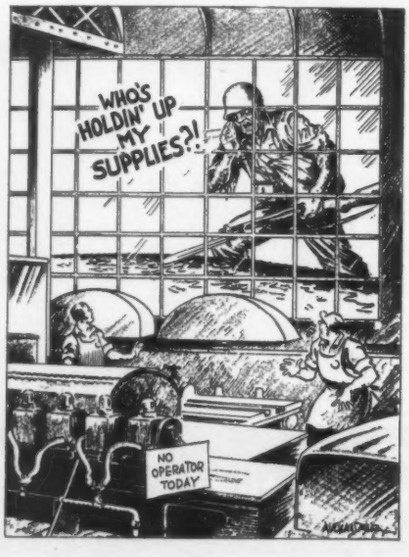
The time lost last year at Baytown due to accidents and sickness amounted to approximately 445,000 manhours.

Just what would have happened if that amount of lost time had been concentrated in one particular division or department at Baytown refinery? Let's see what might have happened. For instance: it would have shut down the entire process department for more than two months. Think of it! Not a single barrel of petroleum products for war would have actually been produced for more than 60 days.

If the amount of time had been concentrated in the railroad department, it would have paralyzed our vital transportation of essential war products for approximately 2½ years.

Applying the figure to the entire refinery, we find that it is sufficient time to shut down the plant for approximately two weeks.

Let's take it just one more step. Suppose the time lost last year had directly affected the manufacture of aviation gasoline. What could our flying forces have done with the aviation gasoline that could have been produced with the amount of time lost? There would have been enough gasoline to keep approximately 100 large bombers in around-the-clock flight.




Fortunately, thus far, the time lost has been distributed over the plant so that no particular unit or department has been understaffed to the extent that operations were impaired. But there is still the problem of replacements, shifting of men and substitutions that must be made when an employe is absent from his post.

Up to this point, we have discussed absenteeism largely from the health and accident standpoint. Of course, most types of absenteeism can be classified under one or the other. However, there are other types that may or may not fall within the two principal classes. For example, we have heard much about "Monday morning sickness," or what has also been termed "payday" or "weekend hangovers." Regardless of what you may choose to call it, this type of absenteeism can be eliminated.

In many war plants this type of ailment is so readily apparent that it can be diagnosed and classified without difficulty. In other plants, it is, unfortunately, disguised under the subterfuge of illness. Over-indulgence can cause a real case of sickness, but we cannot get around the fact that it can be prevented by refraining from over-indulgence. It has been noted, too, that a great many Monday-morning-sickness cases tend to become chronic and employes susceptible to this ailment soon become well-known to the management.

Another type of absenteeism occurs on the job when an employe is absent from his post of duty, machine, or desk for excessive periods. It may be caused by too many trips to the drinking fountain or to obtain soft drink refreshments, and coffee, not to overlook "visiting." Not that we frown upon such practices, but they can be carried to excess. Periodic relaxation and time out for refreshments, et cetera, when properly observed, help maintain production at a maximum. But there is a distinction between relaxation and, if you prefer, loafing on the job.

There are many types of absenteeism that are nation-wide in their scope; there are other types that are peculiar to certain plants. Every survey and investigation thus far made, however, has impressively revealed that those who cause or contribute to the absentee problem are the ones who can reduce it. It is the individual employe who can wage the most successful war against absenteeism by refusing to succumb to the artificial or imaginary causes. It is also up to the individual employe to observe the fundamental rules of safety and health that will avoid the legitimate causes.

There is no absenteeism among our men on the fighting fronts — except real illness, serious wounds, and death!

* Computed under National Safety Council's rules.

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# Refinery Engineering

# The Cargo Plane's Priority Passenger

**An analysis of the vital role of gasoline in air transport, condensed from the February, 1943, issue of *The Lamp*, published by Standard Oil Company (New Jersey)**

CARGO planes are delivering ordnance and other supplies to North Africa, the South Pacific, to Russia and to China. These imagination-stirring examples show that air cargo carriers are here to stay. In coming years the aviation industry will undoubtedly perform feats beyond even its wartime achievements. Even with our present knowledge of power and aerodynamics the size of the craft which designers and engineers could put into the skies, were they called upon to do so, would stagger a Jules Verne. Yet neither the leviathans of the future nor the bombers, transports and cargo carriers of today, not even the tiniest single seater, could fly without fuel.

Fuel is the priority passenger on every flying freighter, dictating how much cargo may be carried; while the extent to which fuel is available along the way determines the routes followed. Planes consume enormous quantities, the gasoline load frequently outweighing the freight load.

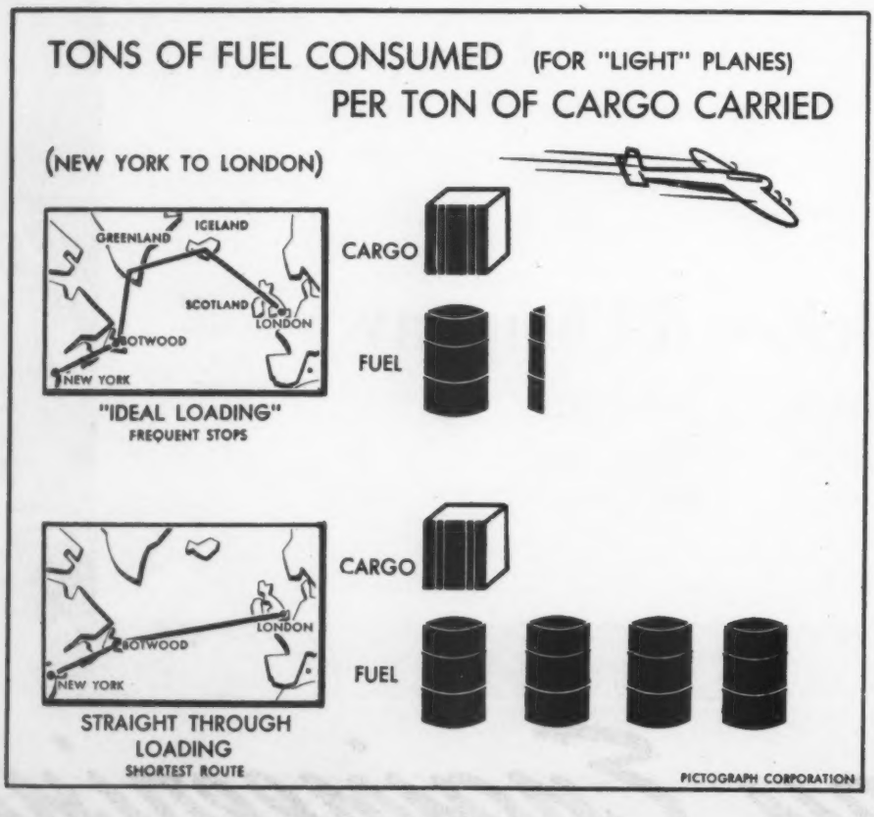
Enthralled by feats of globe-spanning transportation, is it possible that we run the danger of thinking of greater military air fleets too much in terms of steel, aluminum and plant capacity, and not enough in terms of the fuel to fly them?

Let's look at these cargo planes, at their stimulating potentialities and at the conditions which make them of practical use in wartime. The accompanying material is taken from the current issue of *The Lamp*, house organ of Standard Oil Company (New Jersey). In reviewing the picture it is important to remember that under present war conditions all supplies of aviation gasoline must be hauled overseas by tankers—for with the loss of the Netherlands East Indies there is little 100 octane refining capacity on the other side of the world.

If one of the mammoth cargo planes we have been hearing about were to lift its 250,000 pounds over San Francisco tomorrow and, with its six engines beating steadily, head for Australia with enough fuel for the 16,000-mile round trip, the quantity of military supplies it could carry would be exactly nothing.

If a 70-ton aerial freighter similar to the *Mars*, largest transport now in existence, were to load enough fuel for a 12,800-mile round trip to Egypt, it too would have to fly with empty cargo space.

As for the medium type of carrier similar in performance to the B-24 bomber, the only route it could negotiate with enough fuel for the round trip would be the comparatively short 7700-mile New York-to-London run. And here again the crew would be taking her over just for the ride; with any considerable cargo the ship would not leave the ground.




### Tankers Carry Fuel

Of course no one is attempting to fuel such flights for the full round trip—in fact, none of these planes has provision for such a fuel load. Cargo planes are actually delivering military supplies to far corners of the earth; they are able to do so because tankers are ferrying aviation gasoline and engine oil over four oceans of refueling stations that punctuate the routes of the flying freighters.

But this raises another question—whether on some war routes cargo planes will not need as many tankers to haul fuel for them as they replace in ocean freighters.

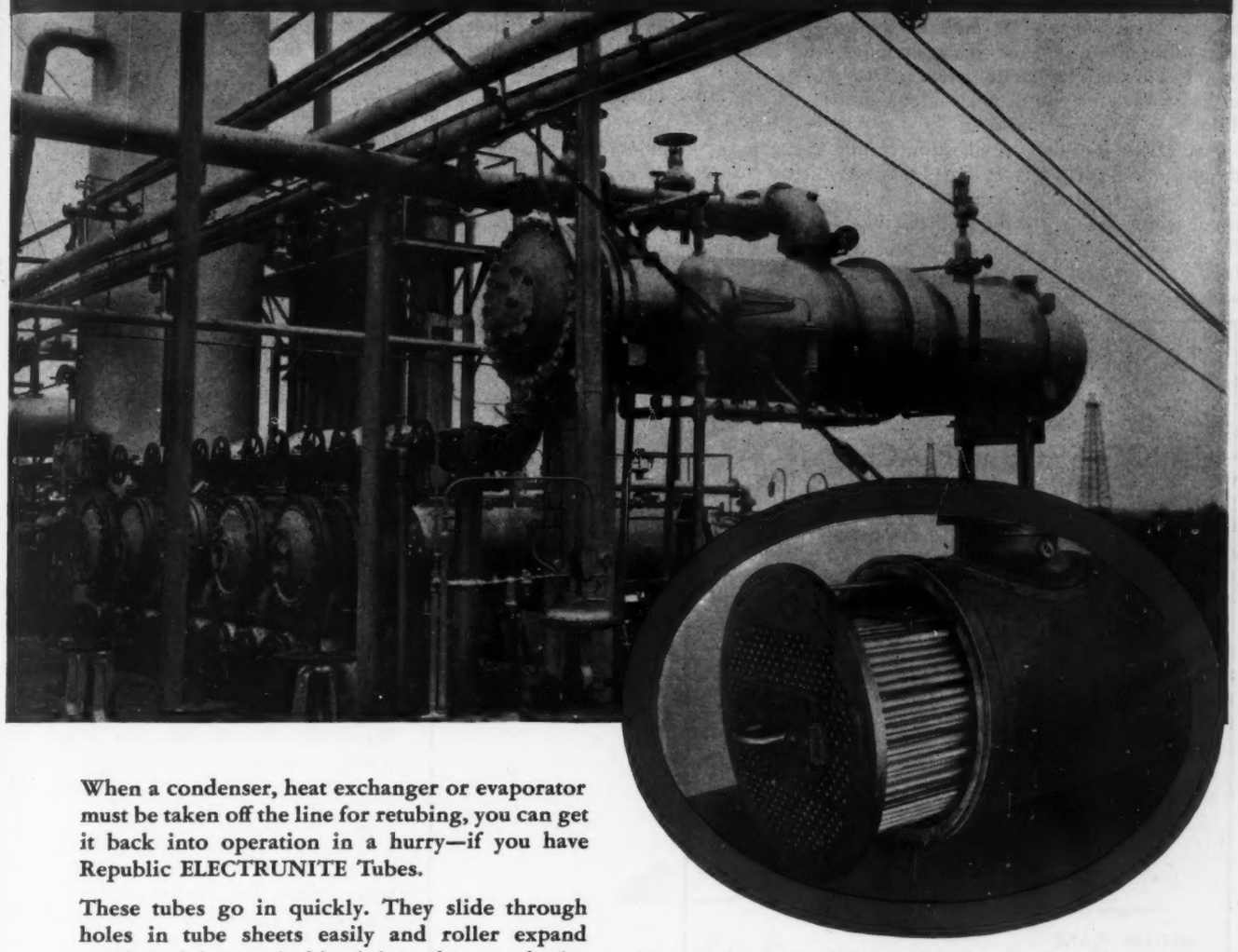
The military value of the cargo plane lies in its flexibility, its speed in getting vitally needed equipment to the fighting fronts, its safety from surface or submarine attack, and the number of ships it replaces.

Most of these qualities the plane will always have. But aside from the heaviest type of carriers, of which only a few have been built so far, every cargo plane now in operation on overseas lanes requires more tankers to keep it in service than it replaces in freight ships.

Present cargo planes operating on long overwater routes (that is, the "light" and "medium" types) consume

WHEN OLD TUBES MUST COME OUT

# *and new ones go in - QUICKLY-*



When a condenser, heat exchanger or evaporator must be taken off the line for retubing, you can get it back into operation in a hurry—if you have Republic ELECTRUNITE Tubes.

These tubes go in quickly. They slide through holes in tube sheets easily and roller expand evenly to tight, non-leaking joints—because they're *CONSISTENTLY* uniform in diameter, wall thickness, concentricity and ductility. They bead over and weld without difficulty. And they bend to required shapes with a minimum of distortion.

ELECTRUNITE Tubes are electric resistance welded from flat-rolled steel. Hence, they are consistently uniform in strength at *ALL* points. Every tube is tested hydrostatically at a pressure within 20% of the minimum yield point of the steel. And every tube is smooth—free from scale and scale pits.

For speed in installation—for long trouble-free service—think of ELECTRUNITE. They're made in carbon steel in sizes from ⅜" to 5" O.D.—in Enduro* Stainless Steel in sizes from ⅜" to 3" O.D.

**REPUBLIC STEEL CORPORATION**

*Steel and Tubes Division*

*Sales Offices • Cleveland, Ohio*

**GENERAL OFFICES • • CLEVELAND, OHIO**

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*Reg. U. S. Pat. Off.

*Republic*

# ELECTRUNITE

Reg. U. S. Pat. Off.

REPUBLIC STEEL PRODUCTION FOR VICTORY

**ELECTRIC RESISTANCE WELDED BOILER, CONDENSER AND HEAT EXCHANGER TUBES**

from one to four tons of fuel for every ton of cargo carried, even under the most efficient operating conditions. Most of that fuel, as we have already noted, has to be carried overseas by tankers.

For this reason it would appear that, in using light and medium cargo planes for transocean hauls of military supplies, the cargo tonnage replaced may be offset by the tanker tonnage needed to carry fuel for the planes under conditions of wartime operation.

And if we consider the question from the standpoint of safety from submarine and sea-raider attack, we come face to face with the realization that, like freighters, tankers carrying the planes' fuel are also vulnerable to torpedoes and shell fire.

The cargo plane has, of course, a definite job to perform. Where speed is vital, or cargo is very valuable in proportion to weight, or where the destination is inaccessible to other transport—all important wartime considerations—the plane is a logical instrument. Let us look at some of the problems associated with expanding the role of the cargo plane in the present conflict.

### How Many Planes?

While exact figures are military secrets, it is possible from various published sources to gain a rough idea—at least for the purposes of estimating requirements of 100 octane gasoline, tankers and steel—of the number of cargo planes we may be able to put into the air through the next year or so. These are shown in the accompanying table.

Not all the steel goes into planes. To construct and maintain in service a fleet of 1000 cargo planes of the heavy *Mars* type would require 270,000 tons of steel—but only a small part of it in the planes themselves. Requirements (assuming eight hours a day average operating time) are:

| | Tons |
|---|---|
| For 100 planes and the manufacturing facilities to build them | 50,000 |
| For additional manufacturing plants for 100 octane aviation fuel | 120,000 |
| For new facilities for making aviation lubricants | 20,000 |
| For tanker construction to transport aviation gasoline to refuel cargo planes | 80,000 |
| Total | 270,000 |

The same ton miles of transportation obtained from 1000 cargo planes under war conditions could be furnished by 20 cargo vessels with an expenditure of only 70,000 tons of steel.

### Planes and Ships

How do cargo planes compare with ships as carriers of military supplies?

A cargo plane is about twenty times as fast as a ship and is much more flexible. It does not have to unload its cargo at the seacoast—possibly under bombardment—but can deliver it direct to its destination.

Planes have taken concentrated food, machines and surgical instruments to Great Britain, Russia and India. They have taken replacement parts for planes and tanks all the way from the United States to the British 8th Army in Africa, and aided materially in maintaining the amazing drive of that now famous band of fighters.

When it comes to long overwater transportation of strategic materials by cargo plane, one factor to be considered is the number of tankers required to haul fuel for the planes, as against the number of ocean freighters they replace.

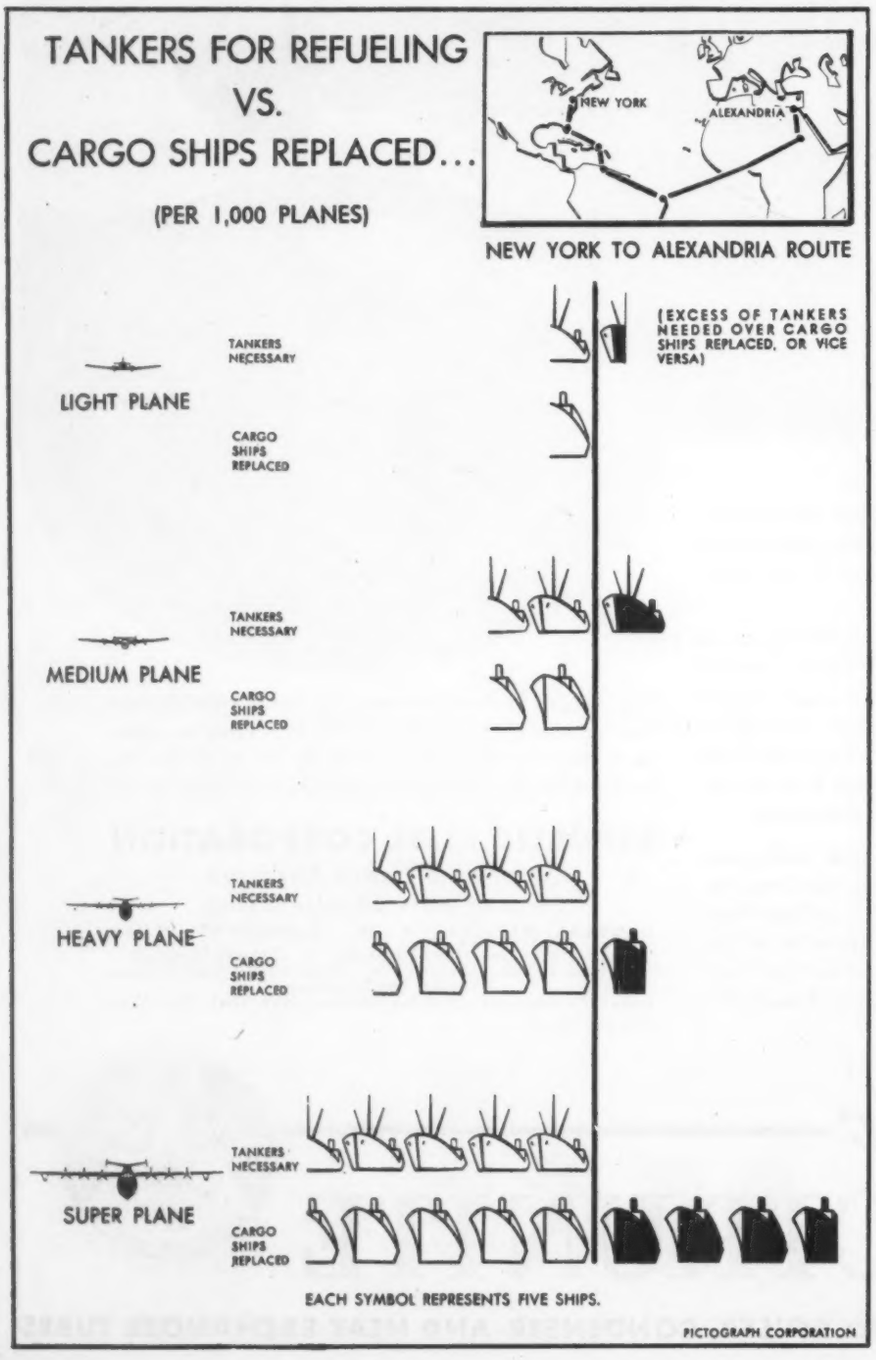
### Fuel Requirements

All inventions must be viewed in the light of the materials and tools with which they work. One of the most important considerations in connection with the military use of cargo planes is the frequency of refueling stops.

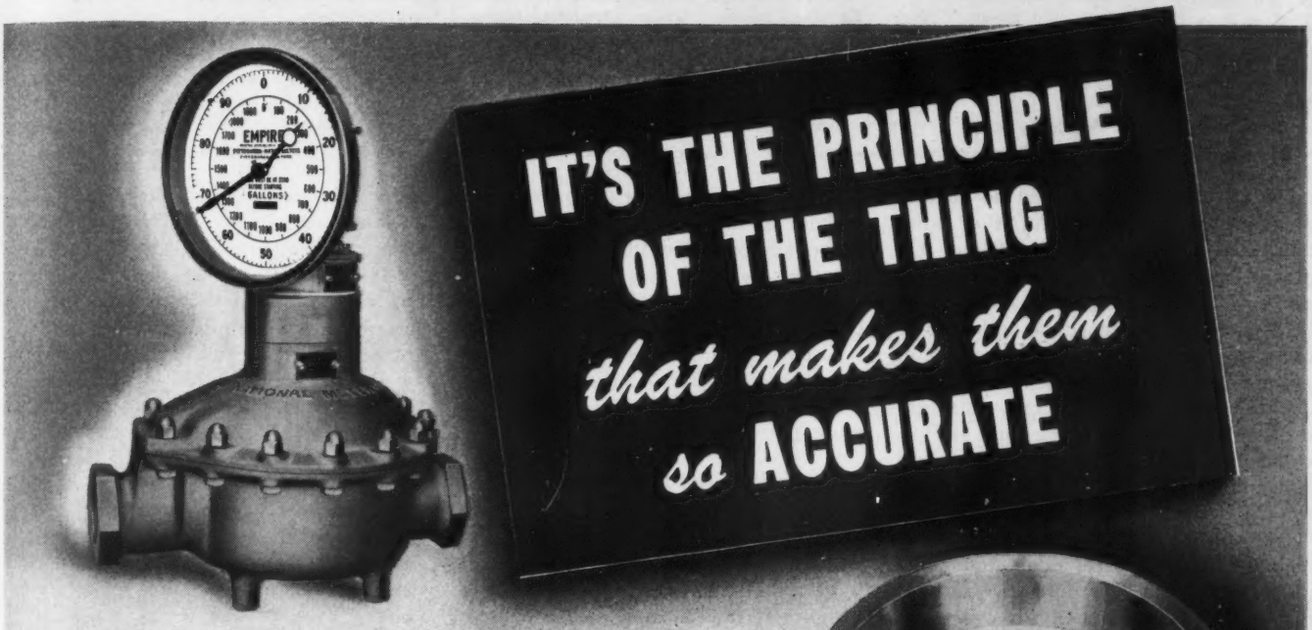
To show how this works, suppose we follow a shipment from New York to London.

Trace this route on the accompanying map and you will notice that there are several possible refueling points on the way—Halifax, Nova Scotia; Botwood, Newfoundland; some point in Greenland; then Reykjavik, Iceland, and a stop in Scotland. The plane might refuel only at Botwood, or it might stop at any combination or all of the remaining points listed.

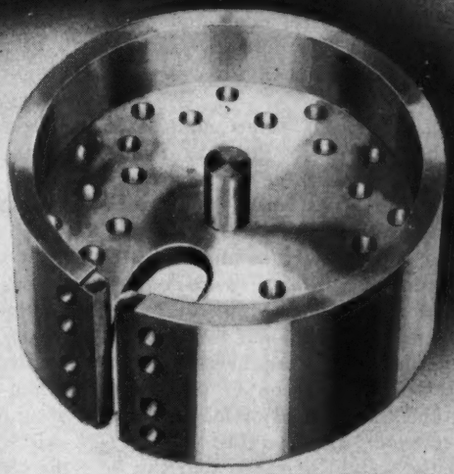
Likewise there is more than one way of loading cargoes for such a ship-



# *In* EMPIRE REFINERY METERS




These meters are made in all sizes from ⅜" through 6", and may be fitted with registers recording in gallons, cubic feet, pounds or other units. Registers of the straight reading type or circular dial (as illustrated) can be furnished.



The famous **EMPIRE BALANCED PISTON** used in all EMPIRE Refinery Meters

PURCHASERS of EMPIRE Refinery Meters gain an added measure of value that no other meter can provide. This "plus" is the extreme accuracy and durability developed only by the famous EMPIRE oscillating piston principle of displacement measurement.

The long life of all EMPIRE Meters and their low cost of upkeep are features as outstanding as their unequalled accuracy. There are hundreds of these meters in the field that have operated 10, 15 and even 20 years without need of a single repair.

EMPIRE Refinery Meters are a sound investment in measurement. They provide in full all the benefits of metering without costly losses resulting from inaccuracy, premature wear or mechanical failure.

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WORLD'S LARGEST MANUFACTURER OF GASOLINE, OIL AND GREASE METERS

## What Cargo Planes Mean in Terms of Fuel, Tankers and Steel

As Estimated by the LAMP

| TYPE OF PLANE | Number of Cargo Ships Estimated in Service | | | 100 Octane Requirement for Cargo Ships Alone (Bbls./Day) | | | Tankers Required for Transporting Fuel | | | Cumulative Steel Requirement for Aircraft, Fuel, Tankers (Tons) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | January, 1943 | January, 1944 | November, 1944 | January, 1943 | January, 1944 | November, 1944 | January, 1943 | January, 1944 | November, 1944 | January, 1943 | January, 1944 | November, 1944 |
| Light | 2,500 | 12,000 | 12,000 | 62,000 | 298,000 | 298,000 | 13.8 | 66.0 | 66.0 | 249,000 | 1,194,000 | 1,194,000 |
| Medium | 1,000 | 6,000 | 6,000 | 49,500 | 297,000 | 297,000 | 11.3 | 67.8 | 67.8 | 190,000 | 1,143,000 | 1,143,000 |
| Heavy | ..... | ..... | 1,000 | ..... | ..... | 66,000 | ..... | ..... | 16.4 | ..... | ..... | 257,300 |
| Total | 3,500 | 18,000 | 19,000 | 111,500 | 595,000 | 661,000 | 25.1 | 133.8 | 150.2 | 439,000 | 2,337,000 | 2,594,000 |

ment. It might be decided to load a plane straight through for the entire trip, stopping only for refueling. Or planes could stop frequently so as to carry maximum freight, and the cargo load could be lightened or added to at each stop, depending on the amount of gasoline needed for the next leg.

On what we might call "straight through" loading, stopping only at Botwood for fuel, a "light" plane might consume 4.05 tons of fuel for every ton of cargo carried. With so-called "ideal" loading, stopping at all intermediate points for refueling and shifting cargo as needed, only 1.29 tons of fuel would be consumed for every ton of cargo.

If you make this same comparison with other routes to the war fronts, and with the other three types of cargo planes already described, you reach these conclusions:

1. Except on short runs and with frequent refueling, you have to carry more fuel than cargo until you reach the heavy type of plane similar to the *Mars*.

2. On the route from here to Alexandria, Egypt, the type of plane employed and the method of loading may make as much as an eight-fold difference in the weight of cargo that can be carried for each pound of fuel consumed.

### Where Is the Fuel Coming From?

Since the more frequently it is possible to stop and refuel, the more military supplies can be transported over a given route, the next question is how are these fuel supplies going to be laid down where they are needed in wartime.

Some say by aerial tankers. But it takes only a bit of figuring to show that, since such planes would have to carry *their own fuel for the return journey,* they would, on most routes, have no room for extra gasoline to fuel the cargo planes.

That brings us back to the lowly tanker and here are some of the conclusions that must be reached for wartime operation:

1. For cargo planes now in use it is necessary to send more than a ton of fuel over the ocean in tankers for every ton of war materials carried through the air.

2. On long routes, to supply enough tankers to maintain in service the 1200 cargo planes called for in one contract recently awarded (assuming the heavy type of carrier), would require 20 new tankers.

3. By making frequent stops for gasoline and thus cutting down the weight of fuel in the tanks, the maximum pay load can be carried.

### Fuel Needs Enormous

It is clear that the most efficient cargo planes on globe-girdling routes are the heavy and the super-classes.

To maintain 1000 heavy-type flying freighters in service over the long routes to the fighting fronts would require a substantial increase in the country's 100 octane capacity, already under heavy demand from the military requirements of ourselves and our allies.

It is understood that the Government plans to refit a number of bombers as cargo carriers. Every time a bomber is converted for cargo use it means an increase in its 100 octane fuel requirements.

Not much is known about the type of military cargo planes now being built. Were they comparable in size to the *Mars,* and assuming they would spend a third of the time in the air, this 1200-plane program alone would require about 3,300,000 gallons of 100 octane fuel a day.

Almost as monumental, particularly from the standpoint of steel required, is the problem of supplying sufficient tankers to haul stores of 100 octane to refueling points along the air cargo routes.

In peacetime this would be less of a problem because 100 octane capacity could be constructed at strategic points in other parts of the world. Even in wartime the most serious study must be given to the possibility of spotting 100 octane plants in Russia and within reasonable distance of the Middle Eastern oil fields of Iran and Iraq.

Every time an aircraft engine burns up 100 gallons of 100 octane gasoline, it consumes 4 to 5 gallons of aviation lubricants.

These lubricants are high quality specialties. Because of the range of temperatures under which aircraft operate, the oils must have a high viscosity index—that is, they must show a minimum change in consistency with extreme temperature variations.

It will be considerable of a job to provide sufficient facilities for the special lubricants required by our military plane program and cargo carriers as well. In normal times to expand aviation lubricant plants would be a 12 to 18 months' job, for the processes involved are complicated.

As a corollary to this action it might be necessary to restrict all top quality lubricants for military use. This would mean the disappearance from the civilian market of premium grade motor oils.

### Refining Facilities Needed

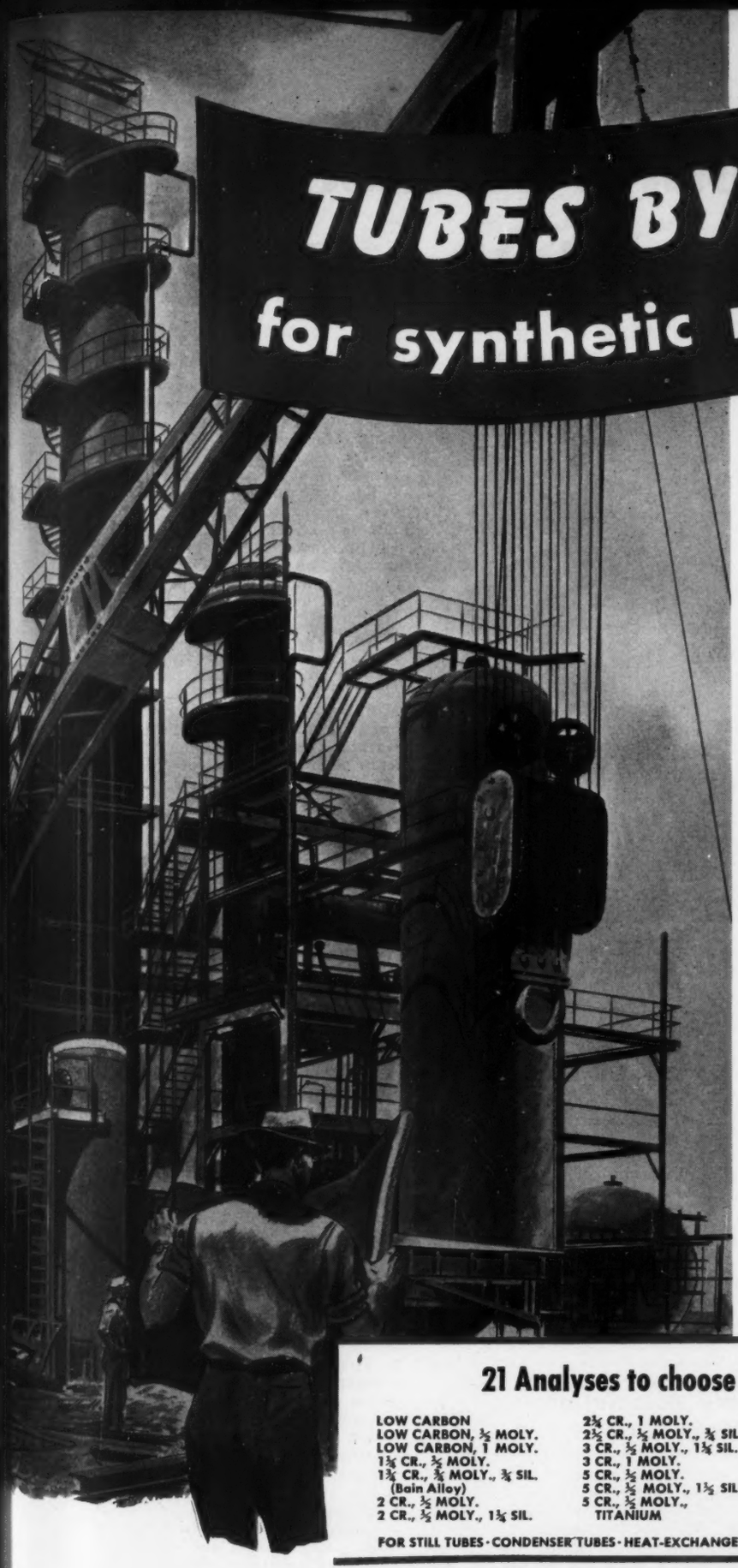
Whether the industry can supply the fuel and lubricants to put into the air such a cargo fleet as is now being discussed depends on how rapidly the steel and other critical materials that must be allocated among various programs of strategic importance can be made available for 100 octane plant construction.

We are working against the clock. Bombers can be converted to cargo use in a comparatively short time. But it takes at least six months to build 100 octane plants, even longer to fabricate and erect aviation oil facilities. Not only must we think of plane construction in terms of fuel, lubrication and other service requirements but we should plan well in advance the expansion of facilities to meet these needs. Failure to do so may mean long lines of cargo carriers unable to get into the air for lack of gasoline and oil in their tanks.

## Stop Use of Fuel Oil In Generating Plants

Use of fuel oil for the generation of power in the East Coast states by any plant able to use any other fuel, will be prohibited April 5 under a joint order of WPB, OPA and PAW, but the interest of the petroleum agency will be confined to instructing suppliers to see that customers are complying with the WPB-OPA regulations.

The order will apply to all plants of 100 kilowatts or more. WPB said there were more than 900 industrial plants and 123 public utilities in the area using fuel oil to generate all or part of their power requirements.



# TUBES BY THE TON
## for synthetic rubber plants!

NATIONAL Tube Company is already deep in the production of seamless steel tubes for various types of synthetic rubber processing plants. Perhaps our "know how" can help you get into operation weeks ahead of schedule.

Time is the all-important factor to consider today—and that's where we can help you most. There's no need to lose valuable days or weeks in determining the proper tube. Our metallurgical staff can help you make the right selections without delay. They know metals and how they will stand up under the various elements used in making synthetic rubber.

Once we have the proper "go ahead," our plants will turn out the tubes in the shortest possible time. On top of this, a NATIONAL Seamless Tube *itself* will save time. It is easy to fabricate, welds readily and has uniform wall thickness. Workmen find they can install more footage before the quitting whistle blows.

### *Send for this Book*

A helpful book entitled "Technical Data for Refineries" gives specifications and properties of each type of steel tube needed for the industry. You can find a world of information on properties at elevated temperatures, corrosion resistance, forging properties, welding practices and the most important applications. It also contains a chart showing comparison of the various types of steel for chromium content, relative cost, tensile strength, creep stress, oxidation susceptibility, Brinell hardness and lineal thermal expansion. Send for a copy today.

### 21 Analyses to choose from*

LOW CARBON
LOW CARBON, ½ MOLY.
LOW CARBON, 1 MOLY.
1¼ CR., ½ MOLY.
1¼ CR., ½ MOLY., ¾ SIL. (Bain Alloy)
2 CR., ½ MOLY.
2 CR., ½ MOLY., 1¼ SIL.
2¼ CR., 1 MOLY.
2½ CR., ½ MOLY., ¾ SIL.
3 CR., ½ MOLY., 1¼ SIL.
3 CR., 1 MOLY.
5 CR., ½ MOLY.
5 CR., ½ MOLY., 1½ SIL.
5 CR., ½ MOLY., TITANIUM
5 CR., ½ MOLY., COLUMBIUM
7 CR., ½ MOLY.
8 CR., 1 MOLY.
17 CR.
18-8
18-8, TITANIUM
18-8, COLUMBIUM

FOR STILL TUBES · CONDENSER TUBES · HEAT-EXCHANGER TUBES · REFINERY PIPING

*During the present emergency the Office of Petroleum Coordinator has recommended to refineries that orders be confined to a limited number of alloy classifications. It will be understood, therefore, that the 21 analyses shown are given as a matter of engineering information, and that some of these alloys may not be available during the period of restrictions.

# NATIONAL TUBE COMPANY

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UNITED STATES STEEL

# Natural Gasoline's Place in War Effort Is Association Theme

Place and prospects of natural gasoline and natural gas in the war program will be the theme of the twenty-second annual convention of the Natural Gasoline Association of America in the Baker Hotel, Dallas, April 14, 15 and 16. Each day has been set aside for one phase of the complete program.

The afternoon of the first day will be devoted to the report of the technical committee. Six subjects will be brought before the group in this session.

Two technical sessions morning and afternoon of the second day will bring that many speakers before the group.

The third day will be restricted to an "information please" type of program. A panel of experts in hydrocarbon processing will answer questions from the floor. During the last meeting of the American Petroleum Institute in Chicago, the association sponsored a session of this nature. Its success was such that it will be repeated as part of the annual convention. The Hanlon Award will be presented at this session.

H. H. Beeson, Sabine Valley Gasoline Company, Shreveport, and chairman of the Technical Committee will preside at the session April 14. The following reports from subcommittees will be made:

Fractional Analysis Project (results to date of cooperative analyses on identical gases by 15 cooperating laboratories), H. A. Montgomery, Hanlon-Buchanan, Inc., Gladewater.

Report of the High-Pressure Gas Division (field tests to determine standard method of sampling two-phase, high pressure gases) W. L. Bowser, The Atlantic Refining Company, Dallas.

Proposed New Method for Obtaining Specific Gravity of Distillate Well Gases, D. A. Sillers, Lone Star Gas Company, Dallas.

Corrosion in Distillate Wells, T. S. Bacon, Lone Star Gas Company, Dallas.

Fractional Analysis by the Mass Spectrometer, Dr. O. L. Roberts, The Atlantic Refining Company, Philadelphia.

Use of the Property of Thermal Conductivity in Fractional Analysis, speaker to be announced.

Speakers and technical subjects of the morning part of the technical program of the second day will be:

Tepetate, Six Years Later, E. O. Bennett and F. B. Haverfield, Continental Oil Company, Ponca City.

The potentialities of Alkylation and Isomerization, Arch L. Foster, Oil & Gas Journal, Tulsa.

The Distillate Industry in the War Program, J. R. Butler, Cotton Valley Operators Committee, Cotton Valley, Louisiana.

The afternoon program will be:

We Will Still Make Natural Gasoline, Ray E. Miller, Hanlon-Buchanan, Inc., president of the association.

The subject of R. C. Alden, Phillips Petroleum Company, Bartlesville, will be announced.

Post-War Possibilities of Natural Gas and Natural Gasoline, Paul M. Raigorodsky and Frank H. Dotterweich, Petroleum Administration for War, Washington.

**RAY E. MILLER**
**President, Natural Gasoline Association of America.**

The information program, the morning of the third day will give the natural-gasoline industry an opportunity of gaining the opinions of some of the leading process engineers of the nation. D. C. Buchanan, director of District 3, PWA, will preside. He will be flanked by three vice presidents of the association, C. R. Williams, The Chicago Corporation, Corpus Christi; J. W. Vaiden, Skelly Oil Company, Tulsa; and H. A. Ells, Cities Service Oil Company, Bartlesville.

Questions will be submitted in writing from the floor. They will be edited and those who give answers will have opportunity of a period of preparation. This session will be "off the record" in so far as reporting is concerned. The press will carry only general statements.

The following process engineers have been invited to assist in this program: Dr. W. L. Faragher, Houdry Process Corporation; A. J. L. Hutchinson, Fluor Corporation; M. C. Keith, M. W. Kellogg Company; Dr. E. R. Smoley, The Lummus Company; Dr. Gustav Egloff, Universal Oil Products Company; R. P. Mase, Frick-Reid Supply Corporation; Louis Weiss, Stearns-Roger Manufacturing Company; M. F. Kotzebue, Gasoline Plant Construction Corporation; Morman K. Rector, Petroleum Engineering, Inc.; from the Natural Gas and Natural Gasoline Division of the Petroleum Administration for War, E. Holley Poe, director; Paul M. Raigorodsky, assistant director; James E. Pew, chief of Natural Gasoline Section; Justin Wolf, assistant chief counsel; A. V. Bourque, associate director, Office of Defense Transportation.

## *Supply Association To Meet April 14*

In addition to playing host for those who attend the meeting of the Natural Gasoline Association of America, the Natural Gasoline Supply Men's Association will hold its annual meeting in Dallas April 14 in meeting room No. 6 of the Baker Hotel. The session has been called for 5 o'clock, immediately following the technical session of the day.

Reports of all committees will be heard and directors elected.

Entertainment for NGAA will be provided the evening of April 15 from 5:30 to 7:30 in the roof garden of the Baker Hotel.

## *Gas Technology Institute Increases Stipends*

The fellowship stipend for students of the Institute of Gas Technology in Chicago has been increased in recognition of the increased living costs of these abnormal times, it has been announced by Dr. Lincoln R. Thiesmeyer, educational director of the Institute.

The stipend now totals $1135 for the academic year of 9 months instead of the usual $1000. The monthly allowance has been increased from $75 to $90 for this year and for the immediate future. In addition, the fellowship stipend includes $325 for tuition and fees.

This action was taken recently when the Gas Institute's board of trustees, through the executive committee, voted to grant this additional allowance.

The executive committee also decided that the summer expense allowance for fellows should be increased from $125 to $140 a month during this period of greater living costs. This allowance is given during the fellows' 3 months of summer training in the gas industry, which is a required part of the training program.

Each academic year is spent by the fellow studying at the Institute of Gas Technology, which is located at and affiliated with Illinois Institute of Technology in Chicago, and each summer is spent in "practical laboratory work" in the gas industry. Here the fellows acquire genuine orientation in various phases of the industry's operations and learn useful applications of the theories and techniques acquired in the classroom.

"The students do not consider this $140 per month as a salary to be compared with that commanded by excel-

# RATING INCREASED BEYOND PRESENT LIMITS

## "Pinwheel Action"

### A NEW GAS BURNER PRINCIPLE — PERMITS GREATER HEAT RELEASE PER CUBIC FOOT OF FURNACE VOLUME

Coppus-Dennis FANMIX Gas Burner utilizes the Dennis principle of combining gas with air in a perfect ratio. "Pinwheel Action" produces complete combustion without impingement — truly "radiant heat". A constant temperature exists throughout the furnace; no drifting hot-spots.

One simple change in your equipment — installation of FANMIX — will give you the extra thru-put you are undoubtedly looking for.

And here's real efficiency. With Coppus-Dennis FANMIX Burner, typical flue gas analysis shows over 11% $CO_2$, a fraction of 1% of $O_2$, no trace of CO., when burning 1000 B.T.U. natural gas.

#### "PINWHEEL ACTION" FOR PERFECT MIXTURE

The energy in gas under pressure does the work. Gas escaping from radially-spaced orifices in driving arms, rotates the fan; this in turn causes intake of air at right angles to the path of the gas. Gas and air are thus mechanically mixed in correct proportions for complete combustion.

#### GREATER HEAT RELEASE PLUS!

Bulletin 410-3 describes other FANMIX advantages: — smaller combustion space, less stack, no forced draft equipment needed, no cracking of wet gas, because driver arms stay below "cracking" temperature. A Coppus "Blue Ribbon" product — precision-engineered, precision-built.

**COPPUS ENGINEERING CORPORATION**
414 Park Avenue, Worcester, Mass.

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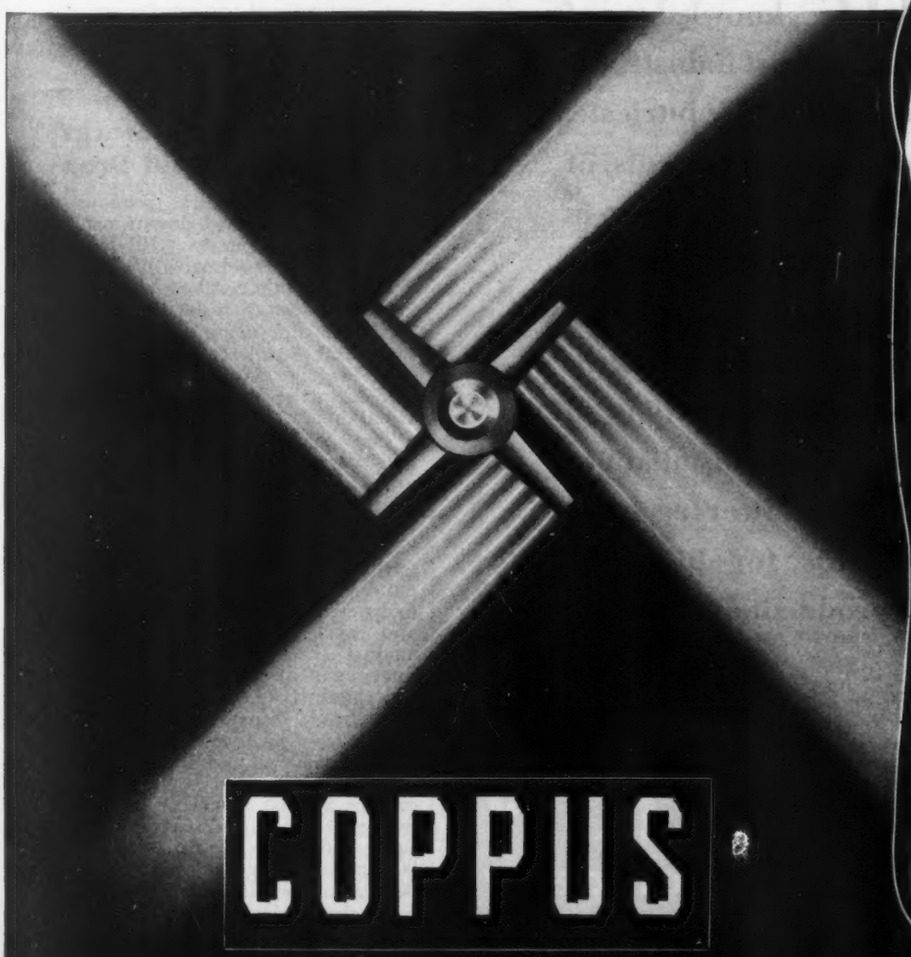

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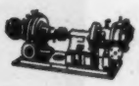
**You'll get valuable ideas from these free bulletins on other Coppus Blue Ribbon Products**

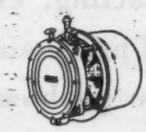
*(Check the ones you want)*

☐ Coppus Cable Manhole and Tank Ventilators. For confined working spaces. Bulletin 163-1.

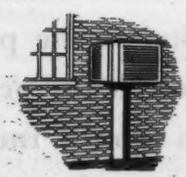


☐ Coppus Steam Turbines. 6 sizes (and prices) from 150 H.P. down to fractional. Bulletin 135-9.

☐ Coppus Heat Killers. Keep production up by keeping men cool. No stale air recirculation. Air is directed. Bulletin 160-5.



☐ Coppus Type C Turbo Blower. For undergrate draft. Bulletin 145-6.



☐ Coppus Air Filters. For engines and air compressors. Perfect, uninterrupted filtration. Bulletin F-310-4.

☐ Coppus-Dennis Fanmix Gas Burner (described in this ad).

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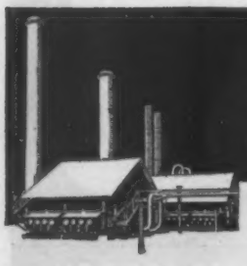
COPPUS BLUE RIBBON PRODUCTS DESIGNED FOR YOUR INDUSTRY . . . ENGINEERED FOR YOU

"The life and soul of science is its practical application."
—Lord Kelvin

1814-1878
Julius Robert von Mayer was led to study in the conservation and correlation of forces by his prior researches on blood and animal heat.

Mayer's work confirmed the theory of the law of conservation of energy and formed a foundation for the accurate measurement of energy and its reciprocal heat.

**Scientific** knowledge of heat has had some of its most industrially useful applications to the many intricate, exacting, everchanging requirements of oil processing. Pioneering 19 years ago in the problems of heating hydrocarbons, Alcorn has devoted its engineering ability to the solution of the heating problems vital to the processing of every type of petroleum product. Alcorn installations in world important refineries have achieved new standards for high efficiency for peak production, for low operating costs.



ALCORN
Combustion Company

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lent young technical men of their experience," explained Dr. Thiesmeyer, "because they recognize that the employing company is contributing invaluable training as well. The contribution of each employing company to the student trainee is rather to cover his expenses in undertaking this phase of the course.

"In even accepting a fellowship for graduate study at this time, the student has sacrificed temporary financial gain in order to make himself of greater usefulness to the gas industry in the future."

"In effecting these financial readjustments, the gas industry expresses again its confidence that a substantial investment in these promising young men will return high dividends when they become a permanent part of its operating personnel," said Dr. Thiesmeyer.

"Student fellows of the Gas Institute are topnotch men who have been awarded one of the best fellowships in the country. It is designed to cover completely their tuition, laboratory fees and modest living expenses. Unlike many scholarships and fellowships this is not granted in exchange for services rendered by the student in instructional or laboratory assisting. Except for the work he is now doing on research projects of military significance as a contribution to the war effort, each man devotes his entire time to scholastic pursuits in gas technology. He is preparing himself for still greater technological service to the nation at war and for leadership in an industry that promises undreamed-of expansion in the post-war era. And he is doing so unhampered by financial stress during this important period of training."

## *Natural Gasoline Stocks Up Despite Output Drop*

Production of natural gasoline and allied products turned downward in January, averaging only 9,701,000 gallons daily as compared with 10,183,000 gallons in December, it has been announced by the Bureau of Mines.

The decline was the first to occur since last April, the bureau said, and was largely due to outstanding decreases in the Panhandle, Louisiana and Oklahoma.

The detailed figures on light products were as follows: Production of natural gasoline, 157,332,000 gallons against 170,058,000 gallons in December; cycle products, 58,800,000 gallons against 57,834,000 gallons; isobutane at natural gasoline and cycle plants, 12,054,000 gallons against 10,332,000 gallons; liquefied petroleum gases at natural gasoline and cycle plants, 72,534,000 gallons against 77,448,000 gallons; liquefied refinery gas at refineries, 18,438,000 gallons against 20,160,000 gallons.

Demand: Used at refineries, 185,850,000 gallons against 207,018,000 gallons; natural gasoline and cycle condensate to jobbers and retail outlets, 35,826,000 gallons against 37,632,000 gallons; liquefied petroleum and refinery gases for fuel, 48,678,000 gallons against 54,390,000 gallons; exports and losses, 33,012,000 gallons against 51,366,000 gallons.

Stocks increased during the month, both at refineries and plants and terminals, at the former rising from 79,758,000 to 86,730,000 gallons, and at the latter, from 114,786,000 to 119,238,000 gallons.

## Synthetic Rubber Outlook Is Brighter

Expressions from William M. Jeffers, rubber director, early in April gave the impression that prospects for synthetic rubber are brighter than indicated by his testimony and statements a month earlier.

In Washington he was credited with a statement that he proposes to resign and return to private industry around July 1, if the progress of the synthetic rubber program continues as now indicated.

Another bit of the news out of Washington had it that Jeffers has written to Senator Guy Gillette of Iowa to the effect that the government may begin to look toward removing restrictions on the use of civilian tires.

Before a Senate committee April 1, where the question of curtailing the guayule acreage was under consideration, Jeffers said synthetic rubber has been perfected to the point where its quality meets virtually all requirements without the need of mixing it with natural rubber. In this instance, however, he said the question of quantity was still critical.

He was confident that the synthetic program will solve this problem and agreed that the guayule program should be curtailed.

## Petroleum Association to Change Meeting Set-Up

In an effort to cooperate with the government to reduce the demand upon railroads and other agencies of transportation, National Petroleum Association is changing the character of the semi-annual meeting to be held in Cleveland, Ohio, April 15 and 16.

Trustees will meet on the above dates at the Cleveland Hotel, in Cleveland, and desire that each member company have one representative present. This procedure will reduce attendance to a fraction of the number who would normally attend the meeting, and will make possible important round-table discussions with government officials directly related to the war effort.

## Shaw in Charge of Jersey Industrial Relations

Charles E. Shaw has been placed in charge of the industrial relations department of Standard Oil Company (New Jersey). His promotion followed the elevation of F. W. Pierce to the board of directors. As executive assistant to the president, Pierce supervised industrial relations. Shaw also succeeds Pierce as chairman of the annuities and benefits committee and as a trustee of the thrift plan.

Shaw has been with the company and its subsidiaries for 23 years. Upon graduation from Columbia University in 1920 he went to work in the employment office of the Bayway refinery. Three years after he became assistant head of industrial relations at the plant, then went to headquarters as assistant to C. J. Hicks, executive assistant to the president in charge of this work. The next year he was back at the Bayway plant as head of industrial relations.

Five years later he headed a similar department for Humble Oil & Refining Company. In 1934 he returned to New York as assistant to F. W. Pierce.

# THE LOOK BOX

## Robinson Resigns From Refining Staff of PAW

P. M. Robinson resigned as assistant director of refining of PAW March 31. For the next several weeks he will be at Detroit, Texas. His leaving came about because of ill health.

Robinson came to Washington as assistant to Dr. R. E. Wilson, who was petroleum consultant of the National Defense Advisory Commission, which in turn became the Office of Production Management. When OPC was set up in August, 1941, he became assistant director of refining.

Previous to coming to Washington he was chief engineer of the Pennzoil Company, Oil City.

Robinson is a graduate of Austin College, Sherman, Texas, 1922, and a graduate of the University of Michigan. After graduation from the first school he went with Gulf Oil Corporation at Port Arthur. Later he worked as an experimental research engineer with E. B. Badger & Sons Company. During this time he studied at the University of Michigan and gained his degree in chemical engineering.

For the five-month period following the resignation of Wright W. Gary, as director of refining of PAW and the appointment of E. D. Cuming, Robinson was acting director. He has been chairman of the technical committee of the Pennsylvania Grade Crude Oil Association, vice chairman of the Pittsburgh section of the Society of Automotive Engineers and a member of the American Society for Testing Materials.

### RARE CHEMICALS

**THE National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago, Illinois, has received urgent requests for the chemicals listed below. If any one has one or more, even if only in one gram quantities, please inform the registry.**

1. **Octene.**
2. **2-chloro pentane.**
3. **Alcohols or mercaptans of the aliphatic series having twenty or more carbons in the molecule.**
4. **Methyl-octanyl-amine.**
5. **Normal Octanol.**
6. **Normal Decanol.**
7. **Dibromoiodomethane.**
8. **Any tetrahydro phenathrene acid.**
9. **Acetylene dicarboxylic acid.**
10. **Di lauroyl peroxide.**
11. **Succinyl peroxide.**
12. **Di butyryl peroxide.**
13. **Acetyl benzoyl peroxide.**
14. **Pyrophosphate peroxide.**

## Western Refineries Told Plant Progress Satisfactory

Satisfactory progress in the plant-building programs for both aviation grade gasolines and ingredients for synthetic rubber was reported to the annual meeting of the Western Petroleum Refiners Association in Kansas City, March 25 by Bruce K. Brown, assistant deputy administrator of the Petroleum Administration for War.

Plants will be completed by June to give the nation half of its anticipated final capacity for 100-octane-aviation gasoline. The year also will see completion of butadiene and styrene plants to match the curtailed rubber ingredients program. Brown further predicted that these units will operate satisfactorily.

The one-day session took the place of the customary three-day meetings, which were characteristic of the organization until 1942. C. L. Henderson was re-elected to his fourth term as president of the association. All other officials and directors were reelected.

H. T. Ashton, manager of Lubrite Division, Socony-Vacuum Oil Company, St. Louis, was the honor guest at a dinner following the business session. Ashton has been a member of the board of directors of Western Petroleum Refiners Association for 25 years and has served as acting president as well as vice president in that period.

Resolutions in memorium were passed in tribute to George D. Locke and Charles C. Smith, former members.

Brown estimated that it will be necessary to process 3,000,000 barrels of crude oil daily in order to get ingredients for the aviation gasoline and synthetic rubber. Since fuel-oil requirements involve necessity of processing another 1,000,000 barrels of oil daily, the refining industry faces the prospect of holding runs at around that level as its part in the war program.

Paul G. Blazer, Ashland Refining Company, chairman of the District 2 refining committee of PIWC, urged refiners of the area to give the committee all possible assistance in working out schedules of plant operation.

The afternoon session was devoted to transportation. Speakers were B. L. Majewski, Deep Rock Oil Corporation; Fayette B. Dow, Washington, counsel of the association and director of the petroleum division of the Office of Defense Transportation; A. V. Bourque, assistant director; and Samuel Niness, also of the ODT staff.

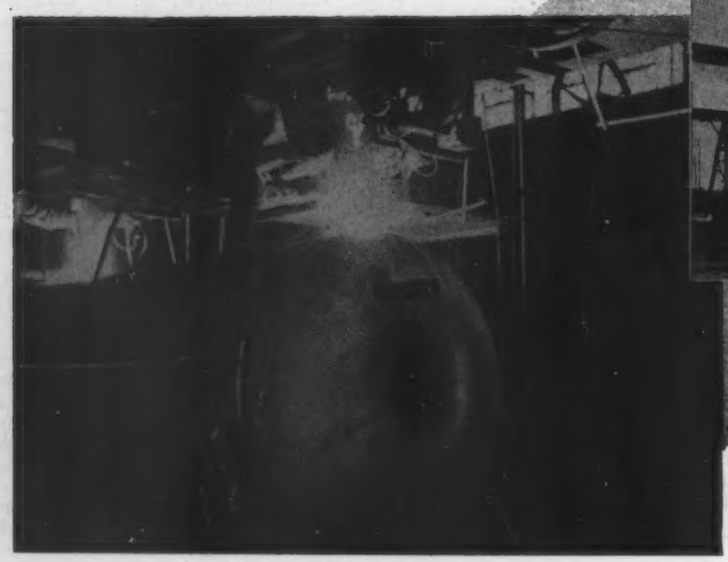
Dow stressed the prospect of continued transportation difficulties during the year, despite completion of pipe lines to the Atlantic Seaboard. He estimated that completion of the 25-inch line to that area would permit shipment of 720,000 barrels daily by pipe lines by December 1. Another 180,000 will be moved by water. Since demand because of military requirements in Europe is expected to hold around 1,600,000 barrels daily it will be necessary to hold rail shipments to the Atlantic Seaboard to 700,000 barrels daily.

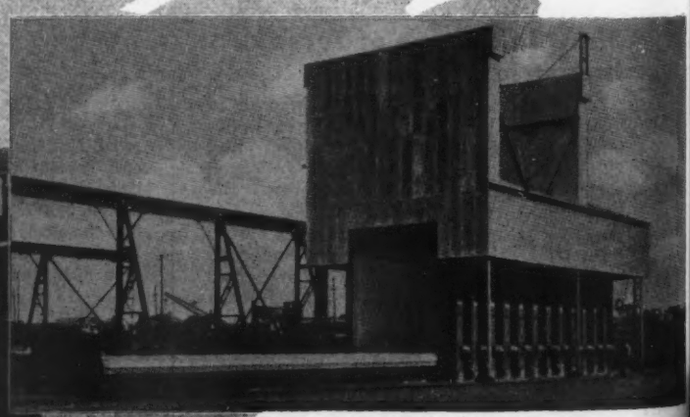
In the reelection of all officials C. L. Henderson, Vickers Petroleum Company, began serving his fourth term as president of Western Petroleum Association. The vice presidents are: R. W. McDowell, Mid-Continent Petroleum Corporation; C. W. Cahoon, Jr., Olney Oil & Refining Company; T. M. Martin, Lion Oil Refining Company; H. E.

# Science Aids B&W MANUFACTURING METHODS on Process Equipment

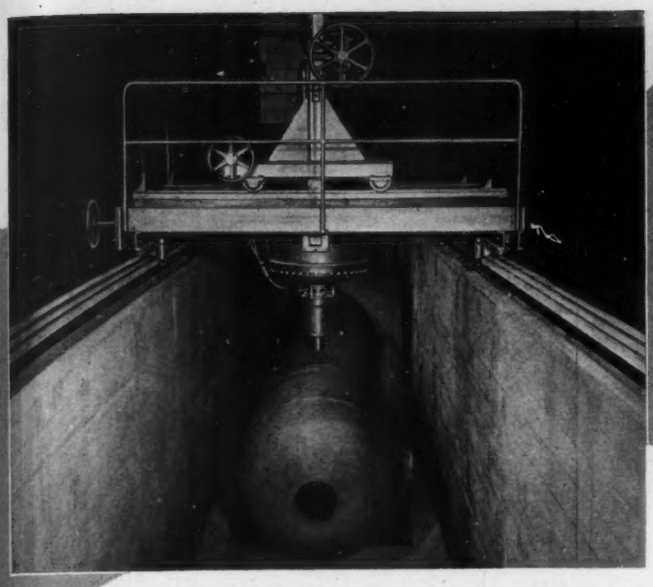
Three modern and scientifically sound operations help build dependability with speed into Babcock & Wilcox high-temperature, high-pressure process equipment.

**WELDING: All longitudinal and circumferential joints are welded by automatic welding machines, other connections are welded manually to drums and shells.**





**STRESS-RELIEVING: After the welded joints have been tested by the X-Ray, and all parts welded to the drum, the drum is stress-relieved by the B&W heat-treating process. The structure is brought up to the specific temperature slowly, at a rate dependent on the wall thickness and the form of the vessel. This entire operation conforms to the A.S.M.E. Boiler Code.**



**X-RAY INSPECTION: As additional guarantee of soundness, every inch of main welds is explored with powerful X-Ray equipment. This examination definitely locates *ANY* defect, shows it clearly, and provides a permanent record of each welded job.**

**Monster elbow connection and header produced by the exclusive B&W forging method. Drum is 66 inches in diameter, tapering to 17-inch opening. The forged elbow tapers from 30 inches in diameter on one end, to 25 inches on the other. Steel plate, four inches thick is used throughout.**

Each of these three steps plays a major role in the efficient manufacturing technique that B&W engineers have developed to save time and steel—important factors in the March to Victory. Ask The Babcock & Wilcox Co. to help meet your need for modern process equipment.

S-36T

The Maritime Victory flag and "M" burgee now flout proudly alongside the Navy "E" at the Barberton Works. Each is an award for "outstanding achievement" and is "an honor not lightly bestowed."

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# Corrosion and Heat — Raiders of Refinery Parts — *Can be Defeated*

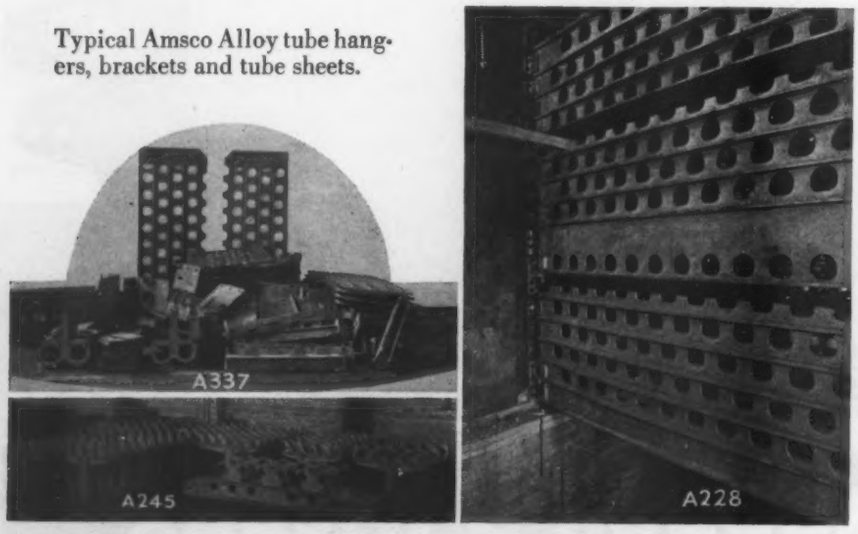
Frequent replacement of metal parts rendered unserviceable by corrosion and high heat was long regarded as a necessary evil. Today, this practice has no place in our war-time economy in the face of the urgent need of conserving metals, and the availability of castings which will resist heat and corrosion for maximum periods.

The corrosive sulphurous gases, high temperatures and heavy loadings encountered in oil refineries and rectifying plants tend to result in excessive replacements and high maintenance costs, to say nothing of the waste of metal involved. These destructive forces are being successfully defied by the proper application of Amsco Alloy parts. This chromium-nickel alloy is made especially to maintain high strength at extreme temperatures and to resist the corrosive action of gases. It gives complete protection against rapid deterioration caused by repeated heating and cooling.

Amsco Alloy is made in a number of analyses to meet various conditions of heat and corrosion, including those encountered in the oil industry. Grade F-10 has excellent resistance to corrosion, and a high load carrying strength at temperatures up to 2100° F. Grade F-8 is serviceable and economical at temperatures up to 1600° F. These grades are widely used in stills, furnaces, cracking chambers and kilns where they are lowering costs by reducing the frequency of replacements. Representative parts are shown.

You will find it profitable to get complete information on Amsco Alloy. Ask for Bulletin No. 108.

Typical Amsco Alloy tube hangers, brackets and tube sheets.

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OFFICES IN PRINCIPAL CITIES


Zoller, Derby Oil Company. John C. Day was reelected secretary and Mary Sue Collins, treasurer.

The board of directors includes the president and the vice presidents as well as H. T. Ashton, Lubrite Division, Socony-Vacuum Oil Company; Paul G. Blazer, Ashland Oil & Refining Company; Reid Brazell, Leonard Refineries, Inc.; H. W. Camp, Cities Service Oil Company; Sheldon Clark, Sinclair Refining Company; O. L. Cordell, Bareco Oil Company; A. M. Hughes, Phillips Petroleum Company; R. R. Irwin, White Eagle Division, Socony-Vacuum Oil Company; R. E. Luton, Ohio Oil Company; F. L. Martin, Sunray Oil Company; W. E. Moody, Deep Rock Oil Corporation; I. A. O'Shaughnessy, Globe Oil & Refining Company; L. H. Prichard; Anderson-Prichard Oil Corporation; K. R. Proctor, National Refining Company; W. G. Skelly, Skelly Oil Company; R. L. Tollett, Cosden Petroleum Corporation; J. W. Warner, Tide Water Associated Oil Company; C. B. Watson, The Pure Oil Company; J. A. Welch, Arkansas Fuel Oil Company; Rex H. Winget, Cushing Refining & Gasoline Company.

Roy B. Jones and L. B. Simmons were elected ex-officio directors.

## Frederick H. Harbison Is Labor Counsellor

Dr. Frederick H. Harbison of the University of Chicago has been selected as labor counsellor to the Petroleum Administration for War. He will act as official liaison representative for this agency in dealing with the War Manpower Commission, the National War Labor Board and the National Labor Relations Board.

It will be his duty to advise and assist the functional officers of PAW in forestalling or remedying labor or manpower situations which impede or threaten to interfere with the petroleum production. In so doing he will be responsible for developing and maintaining effective relations with labor organizations in the industry or for taking appropriate action with management, labor groups and other agencies of the government.

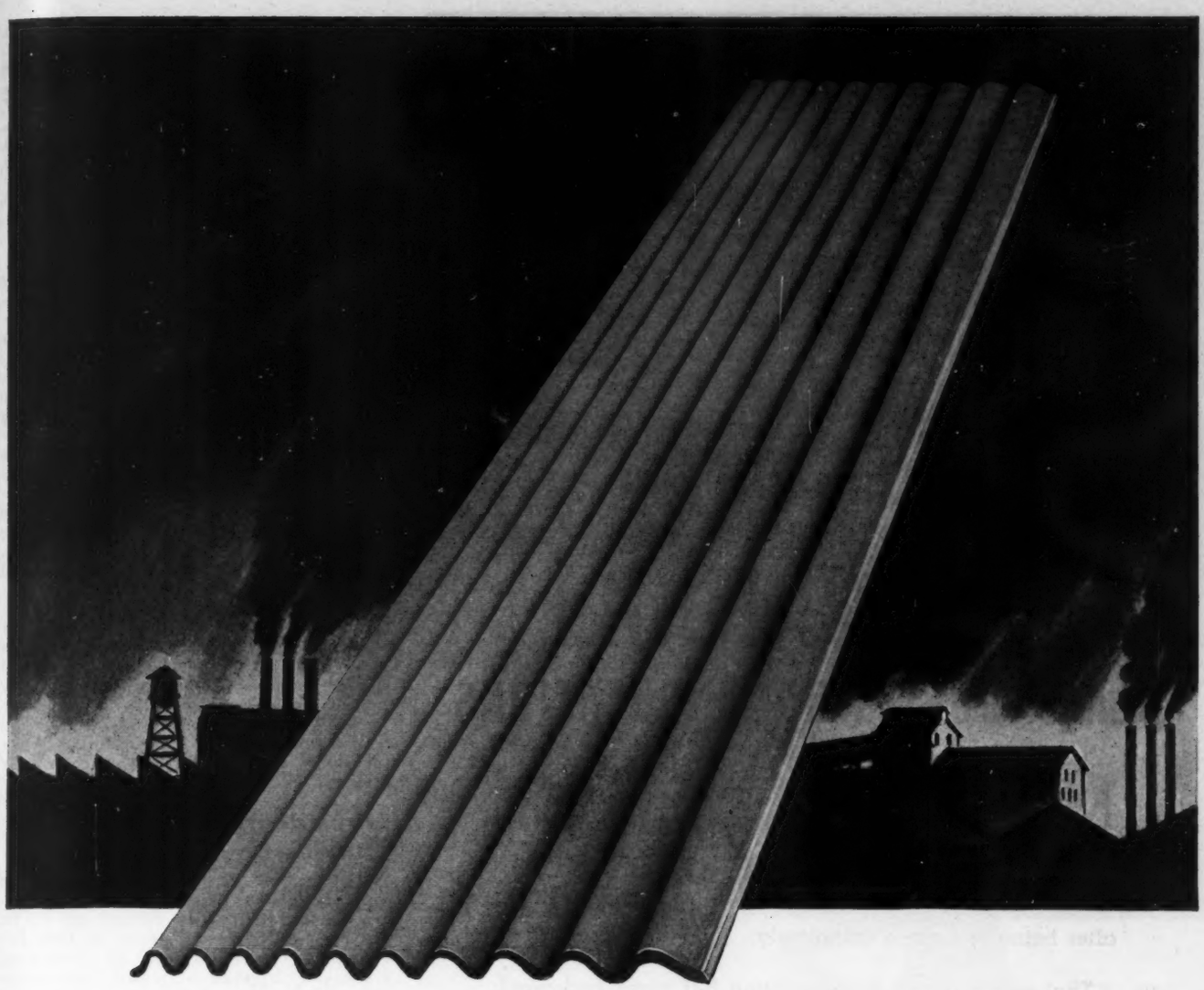
Concerning his appointment Administrator Ickes said:

"It will be Dr. Harbison's responsibility to recommend appropriate policies and programs for determining and meeting the manpower requirements and to integrate them with our wartime programs for production, transportation, refining and distribution of oil."

## Liquefied Petroleum Gas Committee Is Appointed

Formation of a liquefied petroleum gas industry committee to act in an advisory capacity to the War Production Board has been announced.

Paul K. Thompson, chief of the liquefied petroleum gas unit of the plumbing and heating division, is Government presiding officer of the committee, the membership of which includes: L. Abramson, Petrolane Gas Corporation, New Orleans; P. A. Anderson, utilities distributors, Portland, Maine; George W. Bach, Skelly Oil Company, Kansas City, Mo.; M. L. Baker, Standard Oil Company (California), San Francisco; Kenneth H. Koach, Green's Fuel, Inc., Sarasota, Fla.; F. B. Boice, Shell Oil



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## J-M CORRUGATED ASBESTOS TRANSITE!

**For industrial roofs and sidings . . . quickly erected . . . requires practically no maintenance . . . fireproof . . . and provides long life at low cost**

JOHNS-MANVILLE is proud of the way the big, strong sheets of Corrugated Transite are serving the nation in wartime. Made of asbestos and cement, they are establishing outstanding performance records today on industrial roofs and sidewalls and will continue to perform long after the war is won.

J-M Corrugated Transite has these outstanding advantages. It cannot rot . . . it cannot rust. It is highly resistant to acid and gaseous fumes —and it requires no preservative treatment. Easily erected over wood or light steel framing —it can also be salvaged and re-used with a minimum loss of material. For complete details, write for your copy of brochure No. TR-12A. Johns-Manville, 22 E. 40th St., New York, N. Y.

**Some Wartime Uses of J-M Corrugated Transite**

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| MUNITIONS PLANTS | AIRCRAFT HANGARS |
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J-M Corrugated Transite and J-M Asbestos Built-up Roofing are making an important contribution to the protection of our industrial plants in Wartime.

JM Johns-Manville CORRUGATED ASBESTOS TRANSITE

# COMPLETE IMMERSION

*Cannot Soak*

White wool in water saturates and sinks. B-H bobs water-free to the surface.

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## BLACK ROCK-WOOL INSULATIONS

MOISTURE does not disintegrate this utterly different form of rock wool. It does not make it settle. It can't ruin its insulating value. By actual test, B-H black rock-wool absorbs less than 1% of its weight in moisture after being immersed completely.

That is one reason for specifying B-H black rock-wool. Another—equally important—is its stability under heat and vibration. 1400° of flame, which cut their way right through ordinary white rock-wools, leave B-H unharmed. Remember these facts and investigate B-H black rock-wools, felts, blocks and cements.

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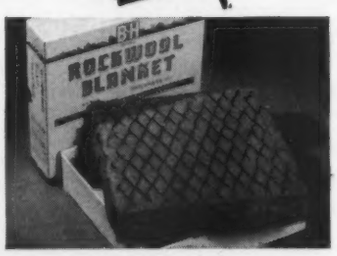
A generous sample of Baldwin-Hill black rock-wool blanket, enough to let you test its heat-resistance, its firm, light texture, and its water-proof advantages. Note its expanded metal-lath surface which makes a cement finish so easy to apply. Simply write for your free sample on your business letterhead.

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Company, New York; G. L. Brennan, Warren Petroleum Company, Tulsa; John Clark, Standard Oil Company of New Jersey, New York; W. T. Joplin, Butane Corporation, Phoenix, Ariz.; W. A. Naumer, Carbide & Carbon Chemical Corporation, New York, and C. D. Whitfield, Phillips Petroleum Company, Washington, D. C.

### *Socony-Vacuum Has New Type Catalyst*

Socony-Vacuum Company Oil has completed its work on a bead-type catalyst, which is now ready for commercial use. The announcement was to the effect that gasoline made over this product should "increase the available power output of aircraft engines by from 23 to 30 percent, depending on the charging stock used. Under comparable conditions, yields of aviation gasoline base stock from given crudes can be increased by from 13 to 30 percent.

"The new synthetic product is called the bead catalyst because it is in the form of translucent spherical particles, resembling small glass beads. As tested in the company's pilot plant at Paulsboro, New Jersey, it proved to be extremely rugged, with far greater strength and resistance to wear than other catalysts; and it has demonstrated exceptional catalytic activity with very little loss in service."

This new catalyst can be adapted to Thermorfor Catalytic Cracking units or Houdry units. It is being licensed by Houdry Processes Corporation.

### *Presidential Order Gives Davies Broader Powers*

Expanding the authority to be given the deputy administrator under the provisions of his order setting up PAW, President Roosevelt issued another Executive Order March 24 permitting Ickes to appoint a deputy administrator (Davies) and delegate to him the power and authority to act in all cases.

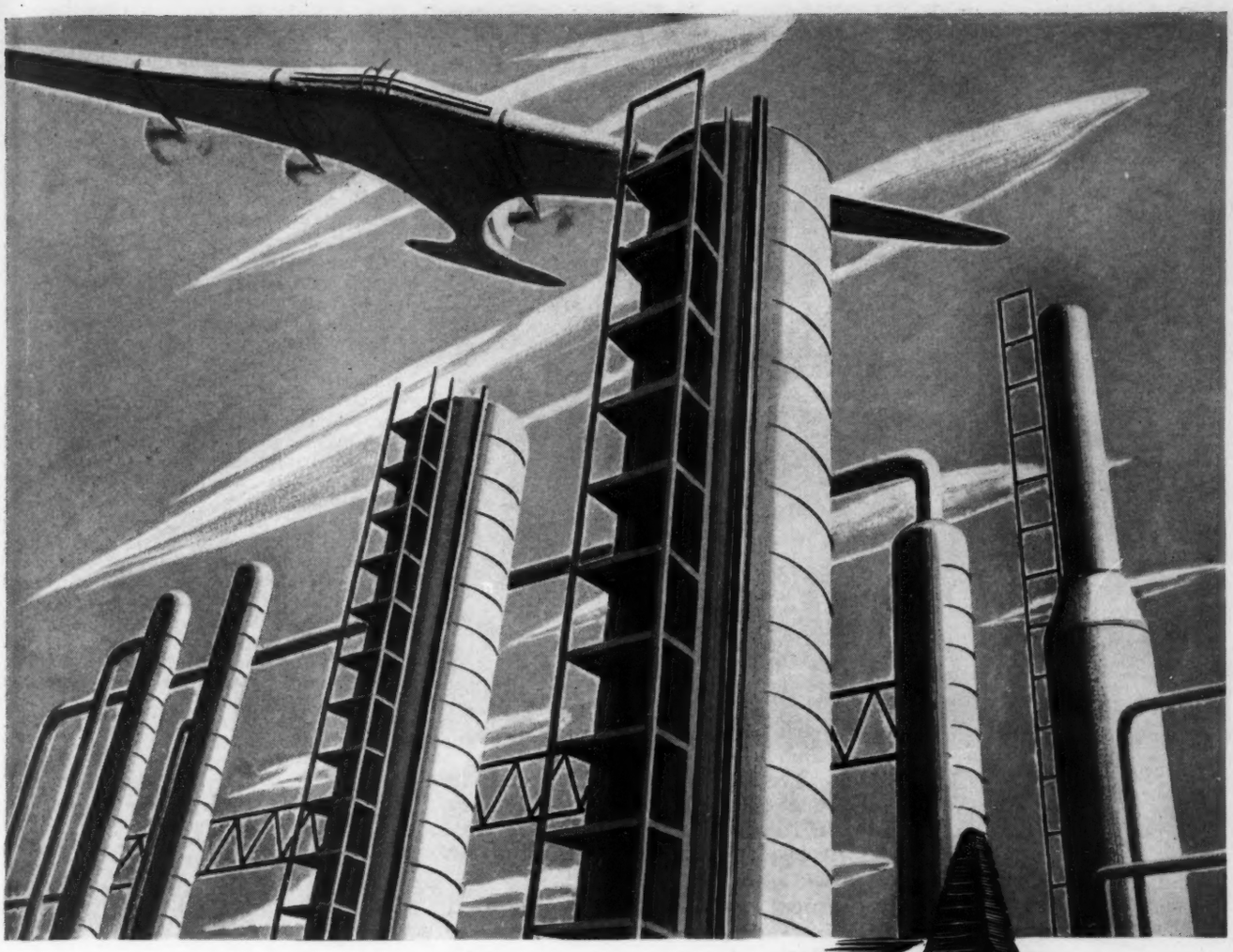
The new order, it was explained, is merely a technical move designed to give the deputy administrator broader powers than he could exercise under the original designation.

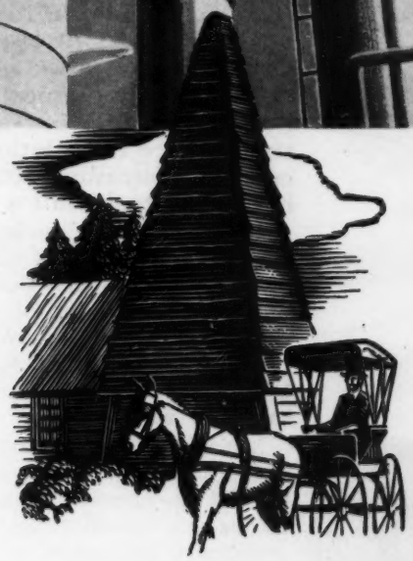
### *Arnold Blames Cartels For Material Shortages*

Charging that our synthetic rubber and aviation gasoline shortages are the result of the concentration of industrial research in the hands of private groups, Appeals Court Justice Thurman Arnold, until recently Assistant Attorney General in charge of anti-trust matters, told a Senate Military Affairs subcommittee March 30 that recurrence of those problems in the future can be averted only by government entry into the field of research.

Arnold threw his support behind the Kilgore bill for technological mobilization, under which the government itself would undertake invention in a big way and would have the exclusive right to use and license others to use inventions, patents and patent rights in the development of which the government contributed any money, credit, physical facilities or personnel.

"Practically all our shortages in basic materials and in chemicals, the very things that are necessary to give us strength in war and wealth in peace, are due to the control of research and





# Looking ahead from a long way back

From the early days of "Colonel" Drake and "Coal Oil Johnny," the chemistry of oil has been destined for great things. Greater even than the high-octane gasoline which today is propelling planes across the sky at 400 miles per hour. Greater than butadiene and toluene.

So, too, with the chemistry of alcohols, phenols, esters, ketones and other organic compounds.

The greater things are sure to come. Many are already germinating—secretly in some instances—and heading toward enriching the world of tomorrow.

It takes background and experience to put into successful production the products chemical research has perfected. It takes *long* experience and far-reaching facilities to design and build new processing equipment that can be expected to operate efficiently.

Badger perspective looks through four generations toward process engineering and plant construction in many future fields. Though busy on refining, rubber, T.N.T. and other war-aid projects, Badger is nevertheless preparing for post-war undertakings. . . . Manned with engineers, designers and draftsmen to convert the new miracles of science into realities. . . . Equipped to plan, build, and to supervise the initial operations of complete manufacturing units.

***LICENSING AGENTS FOR THE HOUDRY CATALYTIC CRACKING PROCESSES***

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***PROCESS ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM, PETRO-CHEMICAL AND CHEMICAL INDUSTRIES***

WELDOLETS, ThredOlets and Socket-End WeldOlets are economical because they cost no more—in many cases less—than any other type of fitting for making right-angle branch pipe outlets.

They are economical because they are installed by electric-arc or oxy-acetylene welding—because they reduce installation time by eliminating all cutting, threading, forming and fitting of the main line to install a tee.

They produce leakproof, right-angle welded branch pipe outlets of full pipe strength, either before or after erection of the main line. They reduce the weight of piping systems, eliminate the need for extra braces at the junction. Because of their wide, funnel-shaped intake aperture they improve flow conditions, reduce turbulence and friction to a minimum.

Made for all standard pipe sizes, they are suitable for every type of piping installation and for all commonly used pressures and temperatures. Stock fittings are of drop forged steel, but can be made on special order of Everdur, Monel, brass, wrought iron, Toncan Iron, etc.

Write for Bulletin WT31 giving full details of all their advantages.

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*Welded Outlets for Every Piping System*

invention by domestic and international cartels," Arnold told the subcommittee. "The production and distribution of such vital elements as magnesium, zinc, rubber, aviation gasoline, fuels, and a variety of other products necessary for both our war effort and our industrial progress have been impeded and delayed, and in some cases totally blocked, because private groups dominated industrial research.

"Cartels have not tried to suppress experimentation. They have tried to corner it. They have kept the savings of new techniques for themselves instead of passing them on to consumers. This has been going on for years and we have just waked up to it. It was not until 139 that prosecutions and senatorial investigations began to uncover the patent cartels in all the necessities of life. The great synthetic-rubber-and-gasoline-patent cartel was formed back in 1929. That cartel was holding back the production of rubber until it could get its new product completely under its control. It was hiding its techniques during the preliminary stages even from the Army and Navy. Had this bill been in effect before the war the Army and Navy would have been as far advanced in the techniques of rubber as the Standard Oil. That knowledge would have been spread to the independent industries that were trying in vain to get licenses under Standard Oil domination. The operation of the rubber cartel was not discovered until 1942. Today millions of citizens lack transportation and the war effort is slowed down because this cartel had a corner on the techniques and the research in rubber.

"This bill attacks the fundamental bottleneck which creates such a corner by spreading knowledge of modern experimentation and the free use of the results of that experimentation to every competing industry."

## Committee to Consider General Oil Situation

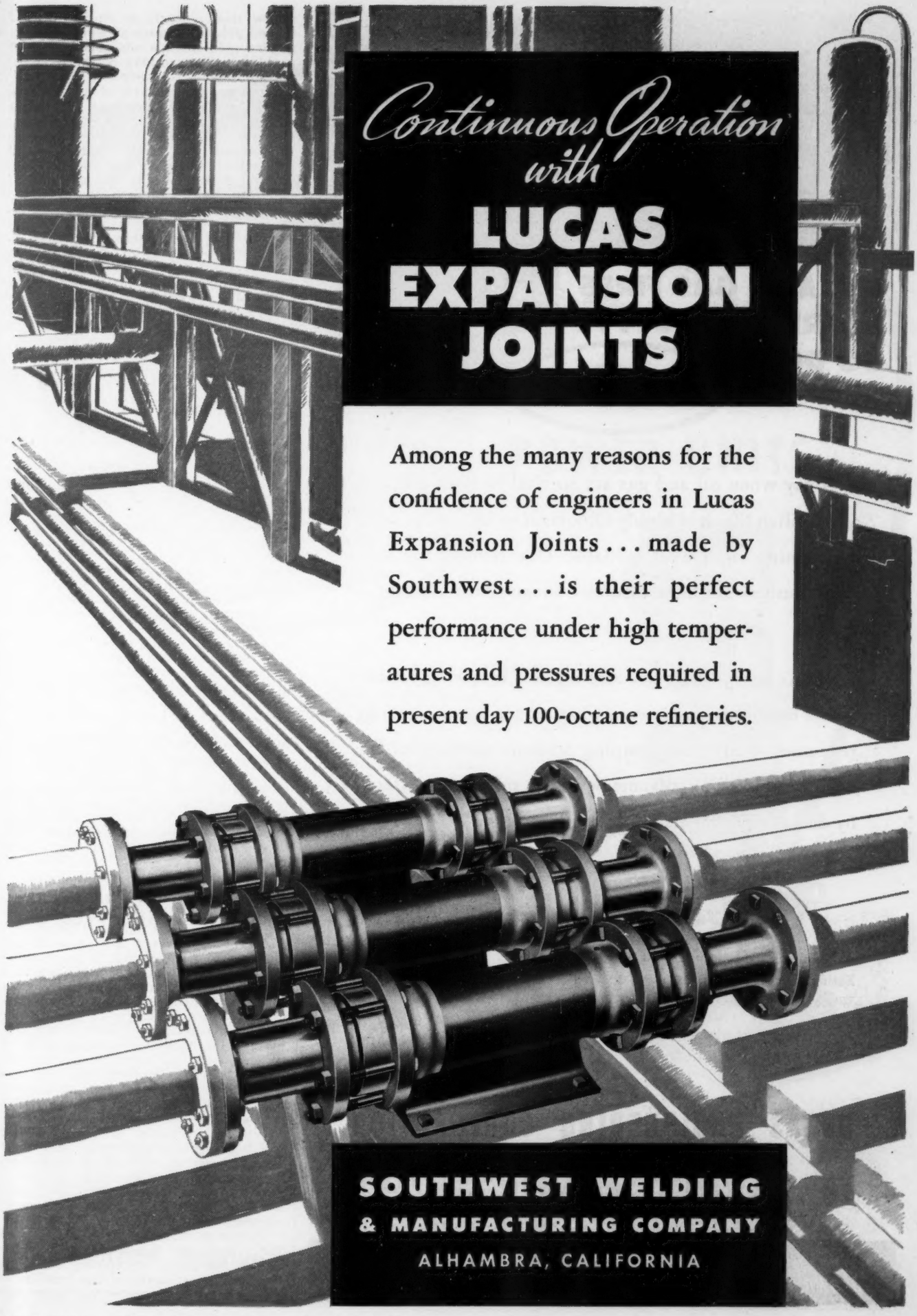
An immediate investigation of the current situation in the petroleum industry is to be taken by the Oil Subcommittee of the House Interstate and Foreign Commerce Committee, it was announced by Chairman Clarence F. Lea of California, following approval by the House of a resolution continuing the group's activities through the current Congress.

Lea announced that he personally will head the subcommittee, which he took over during the illness of former Representative William P. Cole, Jr., and continued after Cole resigned to become a judge of the customs court.

Other members of the group are Congressman Lyle H. Boren of California, Martin J. Kennedy of New York and Oren Harris of Arkansas, Democrats; and Charles A. Wolverton of New Jersey, Pehr G. Holmes of Massachusetts and Clarence J. Brown of Ohio, Republicans.

Lea also announced that Secretary of War Stimson has loaned the subcommittee the services of Colonel John H. Leavell, a former oil producer in Oklahoma and the southwest, to act in an advisory capacity.

Within the next few days, the subcommittee will open its investigation with a hearing behind closed doors on the question of increased production of products for military purposes, and will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LUCAS EXPANSION JOINTS
Among the many reasons for the confidence of engineers in Lucas Expansion Joints . . . made by Southwest . . . is their perfect performance under high temperatures and pressures required in present day 100-octane refineries.
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● Today when oil and gas are so vital in both military and civilian life, it is highly important to have sure, swift fire-fighting equipment available. One refinery fire may mean further rationing, or even a shortage for our armed forces.

DuGas is especially effective on fires involving inflammable liquids or gases, even when under pressure. Many refineries, wells and pumping stations throughout the country are taking advantage of the protection offered by duGas equipment. *Names on request.

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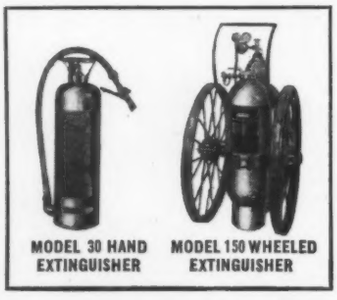

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**MARINETTE, WISCONSIN**

OWNED AND OPERATED BY ANSUL CHEMICAL COMPANY

REPRESENTED IN PRINCIPAL CITIES

DUGAS FIRE EXTINGUISHING APPARATUS IS APPROVED BY UNDERWRITERS' LABORATORIES, FACTORY MUTUAL LABORATORIES

follow this up early in April with extended public hearings at which various government officials concerned with oil problems and members of the industry will be invited to testify.

"It is not the purpose of the committee to confine the hearings to specific subjects," Lea said. "The committee, however, will take up such matters as the necessity of greater and sustained production for the supply of both civilian and military needs; the question of handicaps to production, including the effect of price ceilings; the need of incentive to stimulate discovery efforts and further developments in oil production; transportation as it affects the supply of petroleum and petroleum products for both civilian and military needs; and the extent to which administrative agencies of the government are anticipating and probably providing for sufficient production and supply of petroleum products.

"The committee also plans to go in to the provisions made for the supply and transportation of fuel oil and petroleum products to the East Coast, particularly as to the sufficiency of the plans for such supplies for next winter."

**Investigate Independent's Position**

The Lea group will not be running the only oil investigation next month, however, as Representative Wright Patman of Texas, chairman of the Special House Committee on Small Business has scheduled three days or more of hearings, beginning April 14, on the producing situation, with special reference to the causes of the decline in wildcatting, at which representatives of the industry have been invited to testify, as well as PAW and other officials.

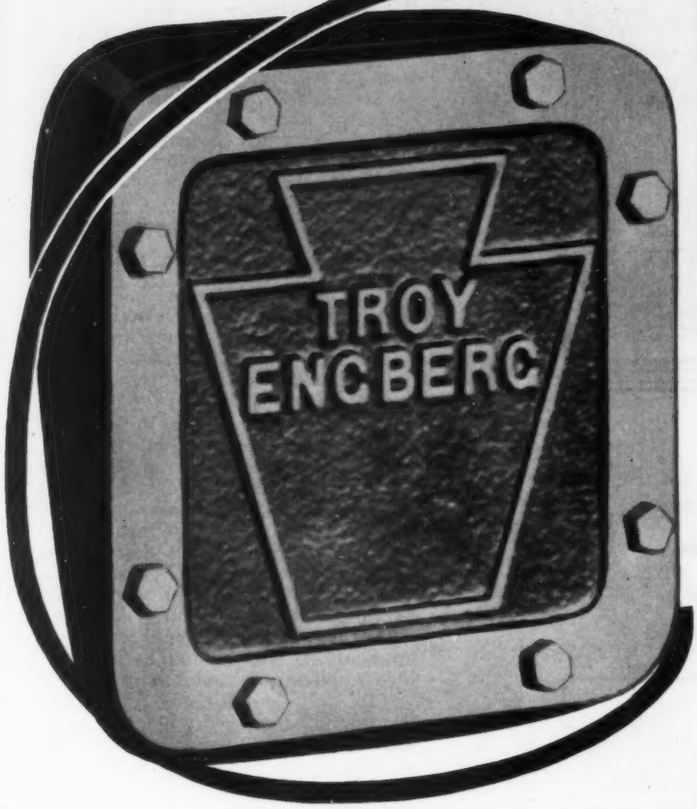
Patman explained that his committee wants to obtain a "comprehensive view of the oil supply situation in national terms," adding that the smaller operators are not responding to the appeals of Ickes and other officials for more exploratory work and that "representations to members of Congress indicate that there are grave ommissions in the national program of emergency regulations which prevent the exertion of the necessary effort on the part of the small producers who usually have found most of the new oil sources in any given year."

## Corn Shortage Threatens Synthetic Rubber Program

Alcohol producers, who a week ago were saved from having to suspend operations by action of the Commodity Credit Corporation in releasing government-held corn, are again facing difficulties which threaten to imperil the synthetic rubber program, it was disclosed March 24 at a meeting of WPB officials with the industrial alcohol producers "advisory" committee.

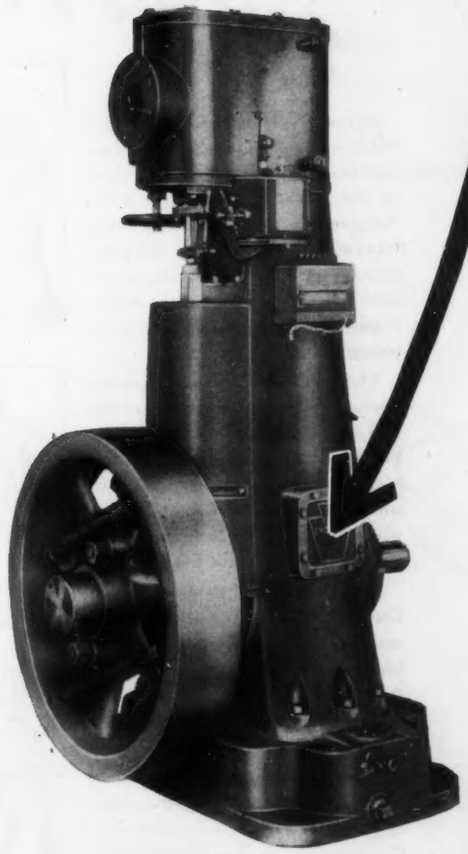
The last reserves of corn at the disposal of CCC are rapidly disappearing, it was explained by Dr. Walter G. Whitman, assistant director of the WPB chemicals division, and since the corporation is making no further contracts for corn after April 1, a number of alcohol producers will be threatened with shut-downs as soon as its supplies are exhausted.

Whitman said the alcohol section of the chemicals division fully understands the crisis threatening war alcohol supplies because of the inability of distillers to buy corn in the open mar-




*The Name-plate On Thousands of*

# LOW COST POWER UNITS



YES, it's the dependable modern steam engine which when plant heat balance conditions are suitable will deliver power for driving equipment at a lower cost than can any other power unit. Costs are frequently low enough so that the savings pay for the engine within a year. And coupled with the low power cost are drive characteristics very desirable for certain kinds of equipment . . . wide speed range and great flexibility; easily controlled automatically; high starting torque and ability to handle sustained overloads for long periods; freedom from fire hazard.

The modern steam engine offers so much as a low cost and otherwise desirable drive that its use should be considered *now* as a replacement for war plant drives now showing signs of wear. With a high priority we can probably take care of you. So, why not look into the matter? Plan now, also, for your post war plant setup.

## TROY ENGINE & MACHINE CO.

***Established 1870***

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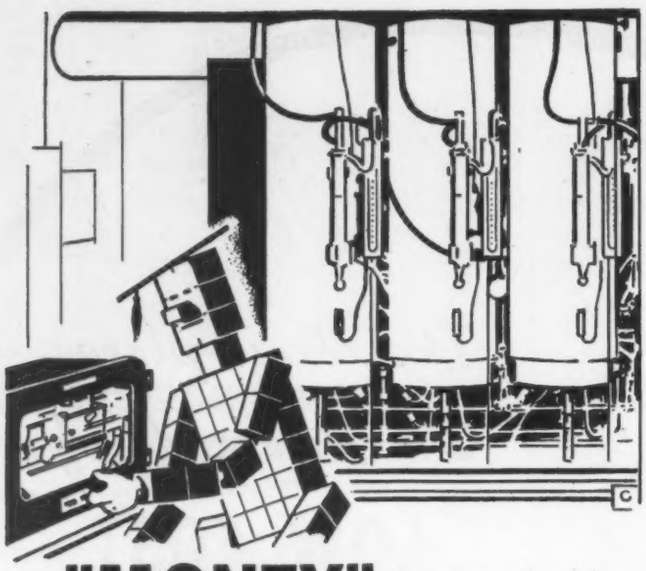
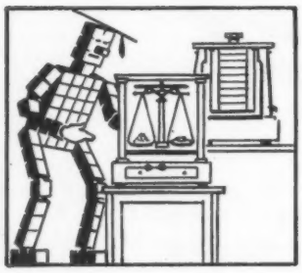


"MONTY" (*Montmorillonite Structure*)

*gets his Ph.D.*



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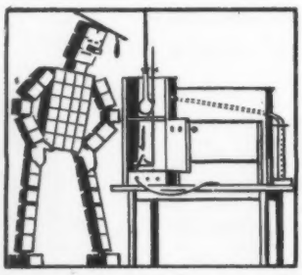
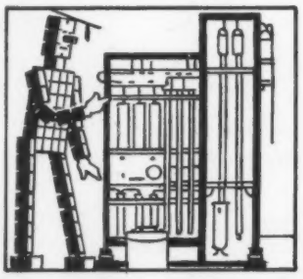
**Chemical tests include percentage and distribution of products and appraisal as to catalytic value. Physical tests which embody the highest standards of hardness and uniformity of size are factors which assure the longevity and ruggedness of Filtrol Catalyst.**



**Filtrol Catalyst, the "Systematic Controller" and the only one with montmorillonite structure, combines effectiveness and economy to solve the dual problem of immediate and dependable production.**

**Data on how to "smash more of the molecules that will help smash the Axis" will be sent upon written request to Filtrol Corporation, 634 S. Spring St., Los Angeles, California. Plants: Vernon, California and Jackson, Mississippi.**



**FILTROL CATALYST**

*to Speed Victory*

ket, and pointed out that plans to take care of the huge demands for synthetic rubber in the fall were based upon a continuously increasing rate of alcohol production, which rate is now endangered.

WPB Chairman Donald M. Nelson, it was revealed, has appealed to Secretary of Agriculture Wickard and Economic Stabilization Director Byrnes for assistance in solving the problem of obtaining corn for industrial alcohol. It did not appear, however, that any success has attended these efforts as yet.

## Gulf Sets Up Fellowships In Eleven Universities

Gulf Oil Corporation has announced the inauguration of fellowships in the fields of physics, chemistry, geology, engineering, and business administration at 11 of the country's foremost colleges and universities.

Application for the fellowships is open to graduates of recognized colleges and universities and to men or women who, through established training and achievement, are able to demonstrate their preparedness for advanced training. Those interested in qualifying should make application directly to the participating institutions. Complete details of the plan, together with the proper procedure for making application, will be made through college publications and scientific journals.

The only condition that in any way limits the schools in selecting a candidate is a provision that if one of the applicants for a fellowship is the child of a Gulf employe and his qualifications are equal to those of others competing, the son or daughter of our employe should be given preference.

## Davies to Sign Oil Exception Orders

All actions on appeals or exceptions taken under War Production Board conservation and limitations orders affecting the oil industry (M-68, M-68-c, L-56 and L-70) will hereafter be issued over the signature of Deputy Administrator Davies under an agreement between WPB and PAW designed to speed up administration of the orders.

The shift of control under these orders to PAW is in line with the policies worked out by the two organizations in accordance with the President's order setting up the administration in place of the old coordinator's office.

## Rowell Now Manager of El Segundo Plant

Richard K. Rowell has been promoted to manager of the El Segundo refining plant of Standard Oil Company of California. His advancement followed the death of H. C. Hanna, under whom Rowell had served as assistant since 1940.

Rowell came to the concern in 1917 as a still cleaner at the Richmond refinery. This service was of brief duration, as he was soon in service and served through World War I in the 225th Aero Squadron.

Returning to Richmond in 1919, Rowell became foreman of the filter plant, and thenceforth advanced steadily through various supervisory positions in the manufacturing department. In 1934 he was transferred to El Segundo

# VINSON

## Supply Headquarters for the Refiner

**FISHER**
Automatic Controllers

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Pipe and Steel Tubes

**TUBE-TURNS**
Tees, Reducers, Flanges and Welding Caps

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"Antimonial Admiralty" Condenser Tubes

Standard Brass Products

*Also Representing Exclusively:*

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FAHRITE
Tube Supports

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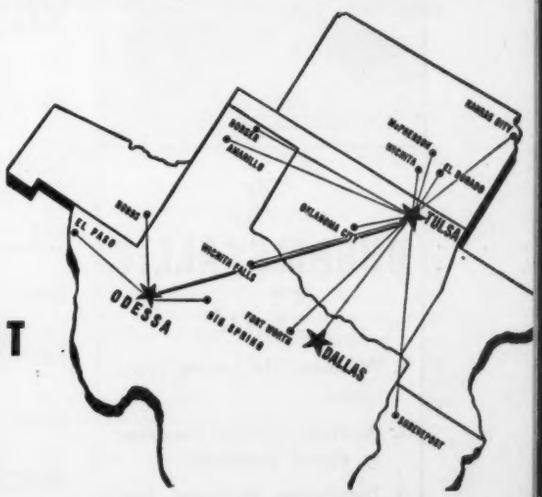


ERVICE THAT *Covers* THE MID-CONTINENT

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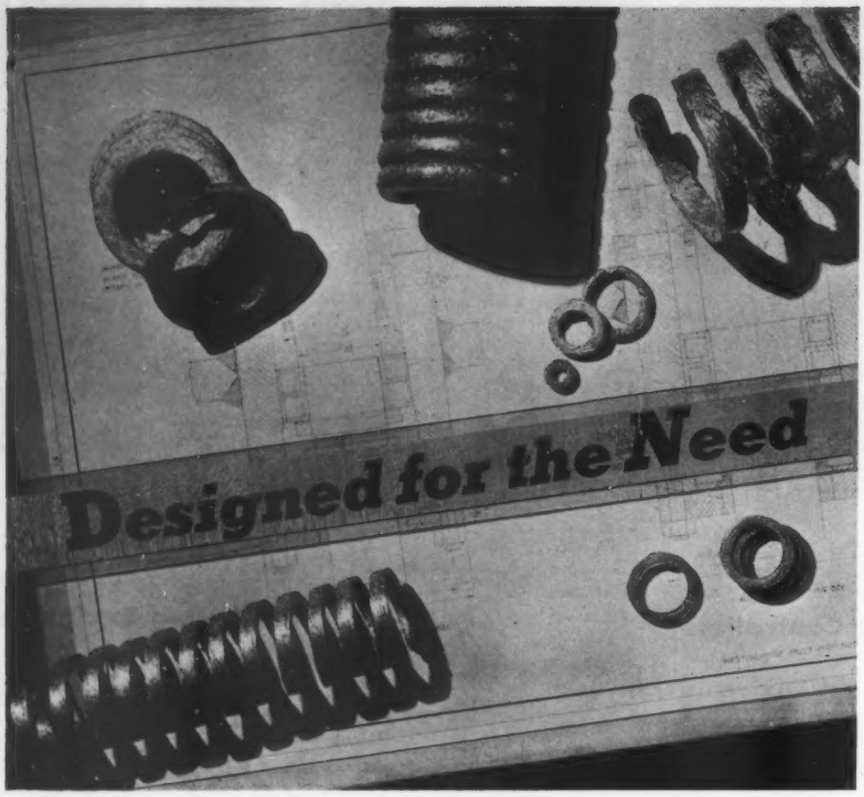
# SUPPLY CO

## nd Natural Gasoline Manufacturer

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THE DURAMETALLIC TWIST

*The* **DURAMETALLIC** *Twist*

1. Processed to retain lubrication.
2. Provides readier response to gland pressure.
3. Distributes frictional load over several diagonally wrapped metallic sheets.
4. Originated by DURAMETALLIC.

Any user of Durametallic Packings will tell you that it pays to use the right type of packing to meet the need. The more difficult the problem, the greater the chances are that you need DURAMETALLIC PACKINGS to provide effective sealing for longer uninterrupted runs.

***Free Engineering Recommendations for Your Packing Problems***

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Manufactured in Canada by JOSEPH ROBB & CO. LTD., MONTREAL

as superintendent of the pressure stills, retaining the title he had held for six years at Richmond. Subsequently he was named refinery superintendent and in 1940 was appointed assistant manager, continuing in the latter position until his recent elevation.

## Lone Star Building Line Between Gasoline Plants

Lone Star Producing Company has started construction of a 25-mile 4½-inch natural gasoline line that will extend from its Brooks plant, near Breckenridge, Texas, to its Plant No. 101, 3 miles southwest of Ranger, where a fractionating unit is nearing completion for the processing of natural gasoline into isobutane, isopentane and other products used for blending with refinery stocks to make aviation gasoline and other war commodities. The Ranger plant is already connected by pipe line with the company's other natural gasoline plants in the district, thus assuring ample material for the fractionating plant.

## Sunray Adds Units For Allen Plant

Sunray Oil Company has completed a Girbotol desulphurization unit at its Allen, Oklahoma, plant and enlarged the capacity of its polymerization unit.

The additions now permit the plant to make codimer, which is going into 100-octane gasoline.

## California Toluene Plant Completed

Completion of a large toluene plant in California is announced by Standard Oil Company of California. Cost of the project was said to be $9,500,000.00. Entire production capacity will be delivered to the government for military purposes. First deliveries from the plant are expected during April.

## New Book Based on Refining Processes

Written in answer to the demand for a brief popular outline of existing petroleum manufacturing processes, a new book, "The Amazing Petroleum Industry," by V. A. Kalichevsky, should be well received by laymen and technicians alike.

The book is an interesting and non-technical resume of what petroleum is —what it does—how it is obtained and transported—how chemists have learned to extract from it gasolines of super-performance by cracking processes — and how essential by-products are derived. In language easily understandable by the layman, the story of petroleum is briefly and clearly highlighted.

There are 12 chapters: Introduction; the production and nature of petroleum; transportation and storage; petroleum emulsions and natural gas; gasoline and crude-oil distillation; cracking; hydrogenation and aviation gasolines; chemical treatment of light petroleum products; chemical treatment of lubricating oils; wax, asphalt and greases; waste refinery products; and chemicals from petroleum.

Dr. Vladimir A. Kalichevsky, the author, has had a varied and interesting career. He was born in the oil city of Tiflis, in the Russian Caucasus. At the age of 15 he became a member of the student Corps of Pages in the serv-

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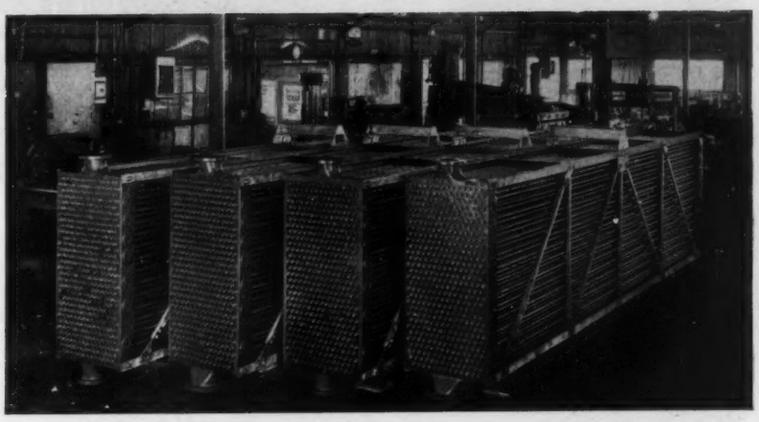
## Natural Gasoline Equipment

"COYNCO" Vertical Atmospheric Stratube Section, a newly developed thru-plug type atmospheric section for handling large volumes, in a number of butadiene and alkylation units.

*We invite inquiries concerning specialized items for the processing divisions of the oil industry.*



*"COYNCO" engineering assures all the latest developments in Shell and Tube, Submerged and Atmospheric practice in keeping with the new WPB Standards.*

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Standard Atmospheric Stratube Sections
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# PIPE DREAMS *Come True*

## In Time to Meet Your Wartime Piping Needs

Acadia SARAN*—that's the name to remember when you need pipe. This new thermoplastic pipe is finding numerous applications in the petroleum industry—not only because of its high tensile strength—not only because it is an ideal substitute for critical metals—not only because of its great resistance to pressure and chemicals—but also because of its easy installation. For SARAN can be joined by a simple, quick welding process or by threading and using SARAN fittings and couplings. Get the whole story—Write for the SARAN Pipe Booklet.

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Processors of
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Sheets • Extrusions • Molded Parts

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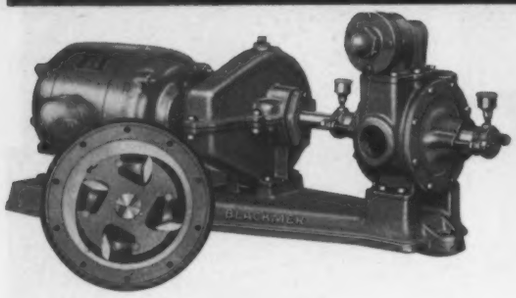

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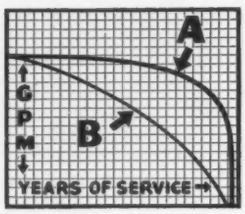
**·ROTARY·**
**PUMPS**

THE PUMP THAT IS SELF-ADJUSTING FOR WEAR
"BUCKET DESIGN"

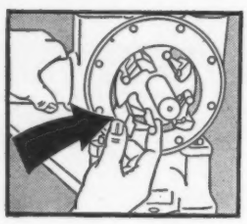
*Have These Advantages*

- No loss of capacity due to internal wear. "Bucket Design" (swinging vane) principle insures constant volumetric efficiency. Curve "A" indicates Blackmer Pump. Curve "B" shows conventional rotary pumps.




- No long "down-time" for repairs. When "buckets" finally wear out, they are replaced in 20 minutes, and the pump restored to original capacity.

  20 years continual service is not unusual for a Blackmer pump.



***For handling viscosities varying from aviation gasoline to asphalt***

POWER PUMPS: Capacities 5 to 750 GPM. Pressures to 300 psi.
ALL STANDARD DRIVES: Single or multiple units.
HAND PUMPS: Capacities 7 to 25 GPM. 54 models.

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"SERVING THE PETROLEUM INDUSTRY FOR 40 YEARS"

**BLACKMER Rotary PUMPS**
"BUCKET DESIGN"—SELF-ADJUSTING FOR WEAR


ice of the Emperor of Russia. During the First World War, he served as captain in the Imperial Russian Guards, where he distinguished himself by winning several trophies for bravery in battle. He was in the civil war in Siberia in 1919, and later accompanied the Royal Rumanian mission to Vladivostok and Tokyo.

As a youth he had an instinctive leaning toward chemistry and engineering. He came to the United States in 1921 and was naturalized seven years later. In 1924 he received a degree in chemical engineering from the California Institute of Technology. Since then he has been a research chemist, first with Union Oil Company of California, then with the Standard Oil Development Company, and finally with the Socony-Vacuum Oil Company where he is now supervisor of research and development.

Copies of "The Amazing Petroleum Industry" are obtainable through The Gulf Publishing Company, 3301 Buffalo Drive, Houston, Texas, price $2.25.

## WPB Ask Speeding Ammonia Cylinder Return

The War Production Board has urged all users of ammonia to speed the return of their empty cylinders to the manufacturers. Steel is not available for new cylinders, and demands for ammonia in war work are so great that all packages must be utilized to the fullest possible extent.

The War Production Board has stated:

"War needs for steel have made it impossible for some time to obtain new returnable steel containers for general use in the ammonia industry. It is obvious that speeding the turnover of returnable containers has the same effect as increasing the supply.

"We ask you to use your best efforts to see that aqua ammonia drums and anhydrous ammonia cylinders do not lie idle for a single day in the hands of ultimate consumers.

"We shall extend our fullest cooperation in assisting you to obtain return of these containers in any case of customer reluctance reported to us."

Large quantities of anhydrous ammonia now are needed by the metal-treating trades for the manufacture of ordnance. These are coupled with normal demands of ammonia for refrigeration.

Manufacturers now have ample stocks of ammonia to take care of emergency needs distributed at key cities over the country, making it unnecessary for plants to keep a reserve supply on hand.

A large cylinder to carry 150 pounds of ammonia requires 240 pounds of steel, one to carry 100 pounds takes 175 pounds of steel, and the small cylinder for 50 pounds requires 105 pounds of steel. Present inventories of cylinders will have to do the job as long as steel is urgently needed for ships, guns and tanks.

## President of Midwest Refineries Dies

B. J. Skinner, president of Midwest Refineries, Inc., Grand Rapids, Michigan, died recently at his home. He had been connected with the oil industry since 1918 and was at one time general sales manager of Marland Oil Company.

## No. 3: Tips on Condenser Tube Maintenance

# How to reduce corrosion resulting from excessive organic and inorganic solids in the cooling water

In some locations, the power plant may be situated where more or less stagnant back-wash water is used for cooling. In such locations it is important that the basin from which the intake canal is fed be dredged clean at least once a year. Otherwise bacterial growth in decaying organic matter on the bottom of the basin may be drawn into the condenser, there to continue growth and decomposition.

This condition, in turn, causes local pitting and plug type dezincification. The tubes, under these conditions, should be frequently cleaned by blowing plugs through them.

Chlorination of the cooling water in the intake canal will kill the bacteria which cause harmful slime in the tubes. Where chlorination is practiced, the tubes will require very little mechanical cleaning, and corrosion due to these causes will be greatly reduced. Chlorine treatment has been successfully applied under the direction of concerns producing chlorine gas and sterilizing equipment.

A request on your letterhead for more complete information on prolonging condenser tube life will receive our prompt attention. 4398

**THE AMERICAN BRASS COMPANY**
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ANACONDA

*Anaconda Condenser Tubes*

# SCIENCE AND TECHNOLOGY

*Abstracts prepared in co-operation with the*

**PETROLEUM REFINER**

*by*

**THE LESLIE LABORATORIES**

Traver Road, Ann Arbor, Mich.

*under the supervision of*

DR. E. H. LESLIE and DR. H. B. COATS

*The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included.*

*Photostat copies of original articles will be supplied at cost by the Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.*

## Fundamental Physical And Chemical Data

**Pure Hydrocarbons From Petroleum,** J. GRISWOLD, *Ind. & Eng. Chem.* **35** (1943) pp. 239-46.

Close-boiling hydrocarbon mixtures deviate from ideality in both vapor and liquid phases to the extent that the relative volatility ($a=P_A/P_B$) calculated as the ratio of vapor pressures, cannot be relied upon. Deviations from the ideal gas law and from Raoult's law usually oppose each other in their effects upon the relative volatility. The system n-heptane-methyl-cyclohexane deviates appreciably from ideality of the solution; this indicates that close-boiling paraffin - naphthene mixtures cannot safely be assured ideal. A fractional distillation method is presented as the most reliable means of verifying vapor-liquid equilibrium data, and for determining the relative volatility of the close-boiling hydrocarbon systems in which a is substantially constant. Re-examination of the vapor-liquid equilibrium and fractional distillation data on the n-heptane-methylcyclohexane system both gave the same value: $a=1.083$. A determination on the n-heptane-iso-octane system gave the value: $a=1.023$. The data are presented in tabular and graphical form. A bibliography of 16 references is included.

**The Carbon-hydrogen Bond Strengths in Ethane, Propane and n-Butane,** E. R. VAN ARTSDALEN, *J. Chem. Phys.* **10** (1942) p. 653.

Carbon-hydrogen bond strenths in methane and ethane were determined from kinetic data by Andersen, Kistiakowsky and Van Artsdalen. The results agreed well with those of Stevenson obtained by measurements of electron impact potentials. Corrected to zero degrees absolute, the $CH_3$ - H bond strength in round numbers is 101 kcal. at O°K., 102 kcal. at room temperature, and 103 kcal. at 450-475°K. The carbon-carbon bond strengths can be calculated by using the data on carbon-hydrogen bond strengths along with other established thermal data. Typical calculations of this type are given. The carbon-carbon bond strength decreases with increasing chain length. Thus in ethane it is $85.6\pm2.3$ kcal.; in propane $83.8\pm3.3$ kcal., and in butane $82.4\pm4.5$ kcal. An increase of one $CH_2$ group apparently reduces the bond strength about 1.5 kcal.

**Solubility of Hydrogen in n-Butane,** E. E. NELSON AND W. S. BONNELL, *Ind. & Eng. Chem.* **35** (1943) pp. 204-6.

The solubility of hydrogen in n-butane was determined at 23.9°, 82.2°, and 115.6° C., and at pressures up to 100 atmospheres. At pressure below 30 atmospheres, solubility decreases with increase in temperature, from 30 to 40 atmospheres temperature has little effect on solubility, and above 40 atmospheres solubility increases with increase in temperature over the temperature range investigated. At concentrations of hydrogen above 3 mole percent, the shapes of the P-T bubble-point curves derived from the solubility data suggest the existence of a region of isobaric retrograde condensation at temperatures far below the critical region of the mixtures. Data reported by Kay for the system hydrogen-naphtha show a similar phase behavior, and it is believed that the measurements on hydrogen-n-butane constitute additional evidence in support of Kay's suggestion that this may be a characteristic property of a general class of mixtures consisting of a liquid and a slightly soluble gas. Data are presented in tabular and graphical form, and a bibliography of 8 references is appended.

**Liquid-Vapor Equilibrium Compositions in Hydrogen Chloride-n-Butane System,** J. H. OTTENWELLER, C. HOLLOWAY, JR., AND W. WEINRICH, *Ind. & Eng. Chem.* **35** (1943) pp. 207-9.

Hydrogen chloride is used as a promoter for the aluminum chloride isomerization of n-butane to isobutane. In a continuous isomerization unit it is necessary to introduce the hydrogen chloride with the n-butane charge in controlled amounts and also to recover it from the reactor effluent for recycling, since the hydrogen chloride consumption must be low if the process is to be economical. Phase equilibria data for the hydrogen chloride-n-butane system are required if absorption and fractionating equipment handling these two components are to be designed with confidence. The literature affords some data on the solubility of hydrogen chloride in propane, hexane, benzene, octane, dodecane and cyclohexane, but nothing on the solubility in n-butane. The apparatus, and the method of operating it, are described in some detail. The compositions of equilibrium vapor-liquid mixtures in the hydrogen chloride-n-butane system were determined at temperatures of 70°, 120°, and 180° F. for pressures below 550 pounds per square inch, using a constant volume type apparatus. The data, presented in both tabular and graphical form as pressure - composition and equilibrium constant - pressure diagrams, indicate general agreement with Raoult's law.

**Ionization and Dissociation by Electron Impact: Butene-1,** D. P. STEVENSON, *Jour. Amer. Chem. Soc.* **65** (1943) pp. 209-12.

The appearance potentials and relative abundances of a large portion of the ions in the mass spectrum of butene-1 are reported. The vertical ionization potential of butene-1 is found to be $9.65\pm0.1$ e.v., or 0.8 e.v. higher than that of isobutylene. The heat of dissociation of the $C_2H_5$—$C_2H_3$ bond is $3.3_0\pm0.2$ e.v. and the ionization potential of the vinyl radical is $9.87\pm0.2$ e.v. The mass spectrum of butene-1 is briefly compared with those of isobutylene and the butanes. A summary of the heats of dissociation deduced from electron impact is included.

**Surface Tensions of Methane-Propane Mixtures,** C. F. WEINAUG AND D. L. KATZ, *Ind. & Eng. Chem.* **35** (1943) pp. 239-46.

Surface tension is becoming a property of some importance in describing the behavior of the petroleum hydrocarbons both in production and in refining. Although the surface tensions of most pure hydrocarbons are known, no data are available for mixtures of known compositions under pressure. To develop a correlation by which the surface tension of hydrocarbon mixtures under pressure can be predicted, data on the methane-propane system over the temperature range 5° to 194° F. and pressure range 40 to 1500 pounds per square inch were obtained. These data were used to establish a pattern by which surface tension data on hydrocarbon mixtures can be correlated. The

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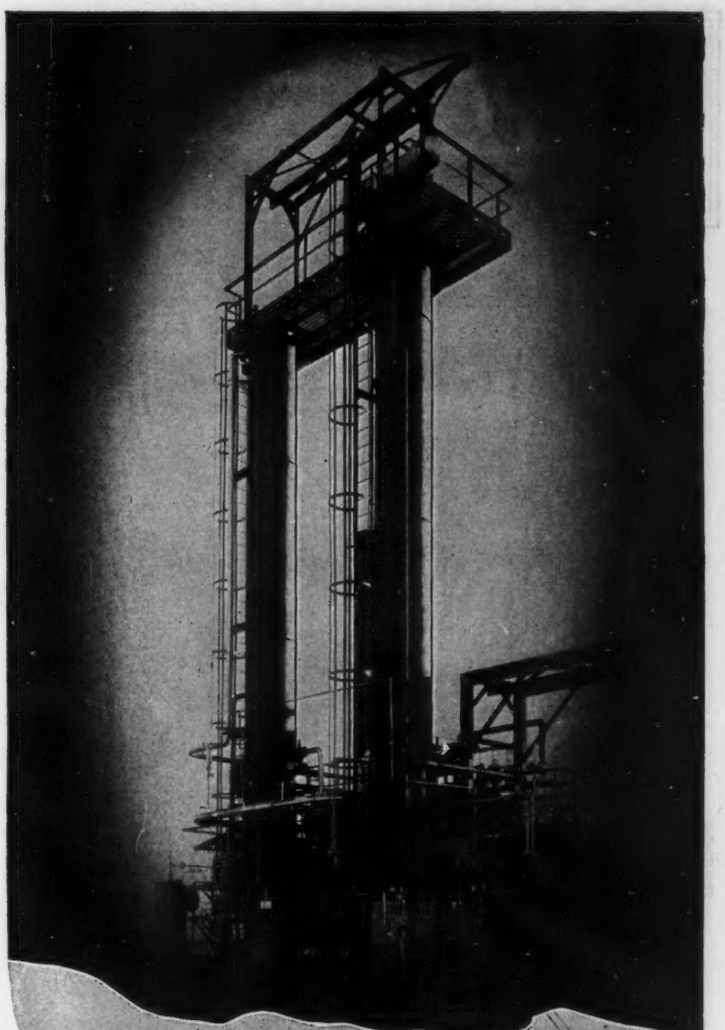

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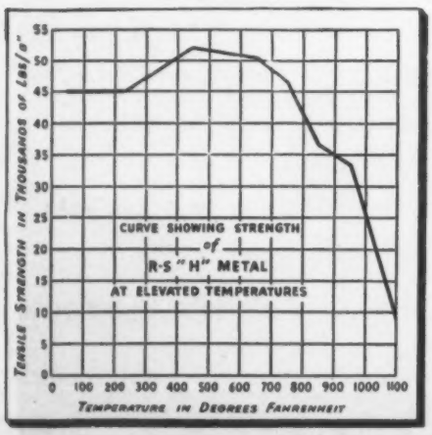


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capillary-rise and drop-volume methods were used in a glass-windowed equilibrium cell. Differences in results between these methods are explained by the high rates of drop formation in the drop volume method. A formula was developed that reproduces the methane-propane data within 0.1 dyne per centimeter. This formula can be applied to any mixture when the molecular weight, density, and composition of each phase are known. The investigation indicated that liquids in the entire critical region have low surface tensions. The apparatus used is described in some detail, and the data are presented in tabular and in graphical form. A bibliography of 28 references is included.

## Chemical Compositions And Reactions

**Aromatics in Turner Valley Crudes,** HENDRICKSON, HUTCHEON AND SPINKS, *Can. J. Res.* **20** (1942) pp. 231-9.

When Turner Valley crude oils are fractionated, all the benzine is contained in the cut from 60 to 80° C., all the toluene in the cut from 90 to 120° C., and all xylenes in the cut from 120 to 150° C. These cuts were examined by the method of specific dispersion. Since the fractions contained no olefin hydrocarbons each fraction may be treated as made up of only two components, the aromatic hydrocarbons and the mixture of paraffins and naphthenes. It was found that the content of benzene in the whole petroleum from representative localities varied from 0.33 to 0.49 weight percent, toluene from 1.3 to 2.18 weight percent, and xylenes plus ethylbenzene from 1.71 to 2.71 weight percent.

**The Photo-Addition of Hydrogen Sulfide to Olefinic Bonds,** WM. E. VAUGHAN AND F. F. RUST, *J. Org. Chem.* **7** (1943) pp. 472-6.

Hydrogen sulfide readily adds to olefinic bonds under the action of light. Radiation of short enough wave length to dissociate hydrogen sulfide is necessary. The requirements are met by a quartz mercury arc and quartz reaction vessel. The sulfhydryl group, like the mercapto group, adds to the carbon atom bonded to the greater number of hydrogen atoms. If the olefin bond is at the end of the chain, the only products are the primary mercaptan and the di-normal sulfide formed by combination of the mercaptan and the olefin. The reaction is fairly rapid at room temperature. 1-Butene and hydrogen sulfide in the molar ratio 1:2 were illuminated for 4 minutes in a quartz tube at 0° C. with a full radiation of a quartz mercury arc. Approximately 80 percent of the 1-butene had reacted during the 4 minutes period, and approximately 85 percent of the product was n-butylmercaptan, and 15 percent di-n-butyl sulfide. Propylene and hydrogen sulfide combined similarly, although to a slightly less extent. Other sulfur derivatives can be synthesized in the same manner.

**A Color Test for Certain Carcinogenic Hydrocarbons,** E. B. LISLE, *J. Chem. Soc.* (1942) p. 584.

Pure filter paper steeped in a solution containing 4 grams of silver nitrate in 100 cc. of water and 5 cc. of an 0.08

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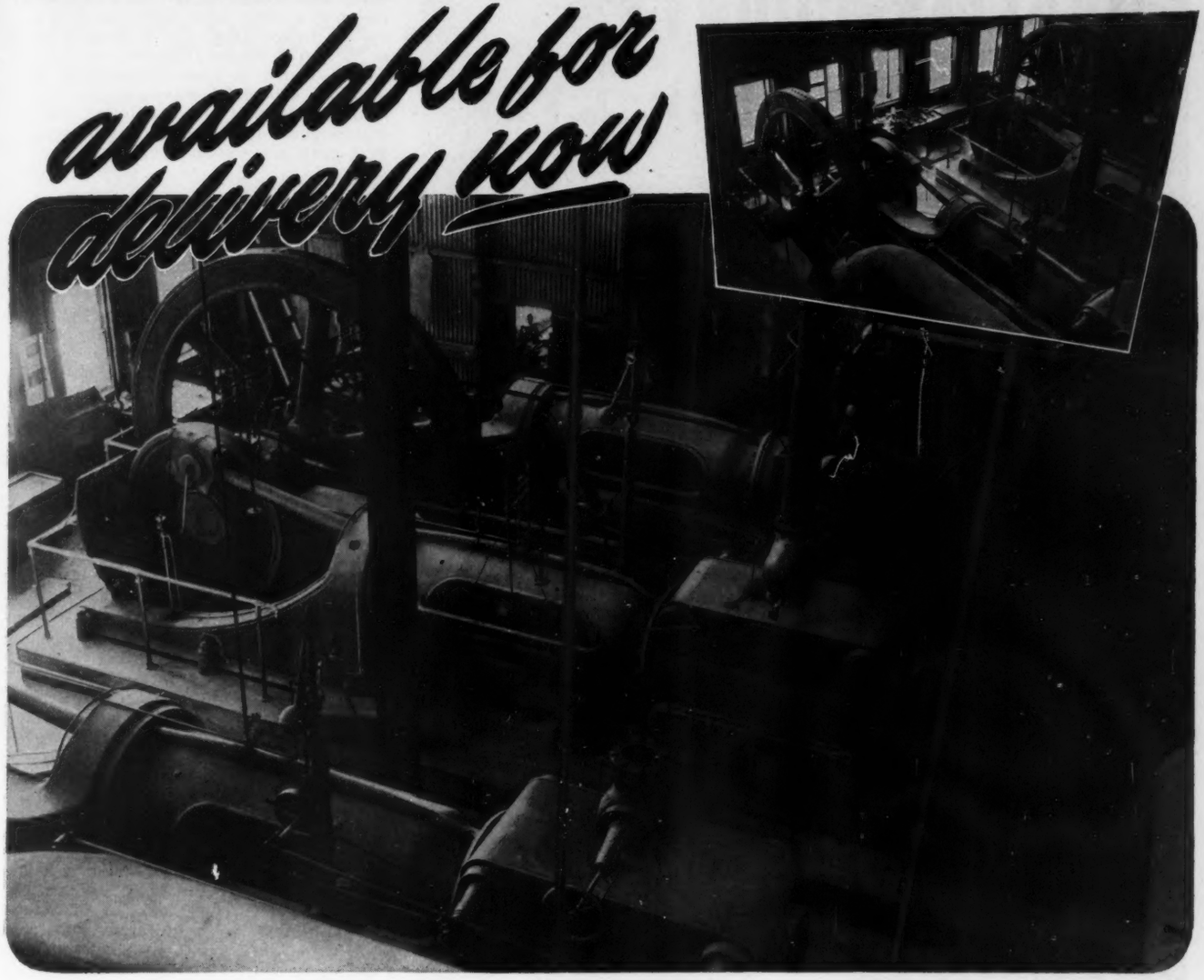

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percent solution of methylene blue can be used as a test paper. The papers are dried and stored in the dark. To make the test a drop of a solution of 2 mg. of the hydrocarbon to be tested in 10 cc. of pure toluene is placed on the test paper, which is then illuminated with light of 4200-4400 wave lengths for 5 minutes. If any one of many of the carcinogenic hydrocarbons is present, a blue-gray color soon develops.

## Manufacture: Processes and Plant

**Fluid Catalytic Cracking Plant Begins Operations at Bayway,** EDITORIAL STAFF REPORT, *Chem. & Eng.* **50** (1943) pp. 132-3.

Development of the "fluid" catalyst in cracking is one of the outstanding technological developments in the petroleum field within the last few years. The first unit in the East utilizing this principle has been just officially opened by the Standard Oil Company of New Jersey at its Bayway refinery. It is now producing large quantities of high-octane base stock for a superior aviation gasoline. In the "fluid" process the catalyst, which is really a solid so finely divided that it can be handled like a fluid, is suspended and flows along in intimate admixture with the oil stream passing through the cracking chamber. The important operating advantage of the fluid process is its complete freedom from mechanical means for moving the catalyst or changing the flow of the cracking or regenerating stream. The only mechanical equipment involved is the pumps that initially deliver the oil to the vaporizing furnaces and a blower that delivers air to the catalyst regenerator. The catalyst is circulated in a manner analogous to an air lift, using the petroleum vapor being cracked or air for regeneration. The "fluid" catalyst eliminates the requirement of forming the catalyst into lumps that can withstand without deterioration the alternating temperatures of the fixed bed type of operation as well as the abrasion of high velocity gases. Several types of catalysts are thus made available to this new process that otherwise would be impractical. This, in turn, permits greater control over the products made in the cracking operation. The process can produce a wide variety of petroleum products, such as aviation base stock, motor gasoline, heating oil and mixtures of ethylene, propylene, butylene, isobutylene, isobutane and isopentane. Two other fluid catalystic cracking plants are now in operation; one in Louisiana and one in Texas. Some 33 of the units are scheduled for operation in this country, and when these are in operation this process will have the largest cracking capacity of any process. The raw material is gas oil with an A.P.I. gravity range of about 27-35°. The catalyst, delivered to the plant in box cars and unloaded by air hose, is fed into a pipe through which hot vaporized gas oil is pumped under about 10 pounds pressure toward a reaction or cracking chamber. The temperature of the mass in the chamber ranges from 800 to 975° F. Pressure at the top of the cracking reactor is about 10 pounds per square inch gage and at the bottom about 15 pounds per square inch gage. The catalyst is recovered by passing the entire mixture from the reaction unit through

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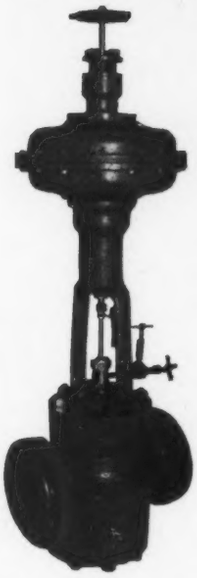

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*Exterior View*

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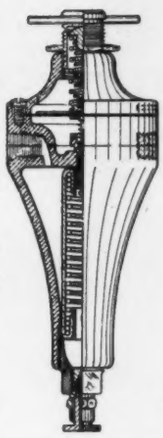

*Cross-Section View*

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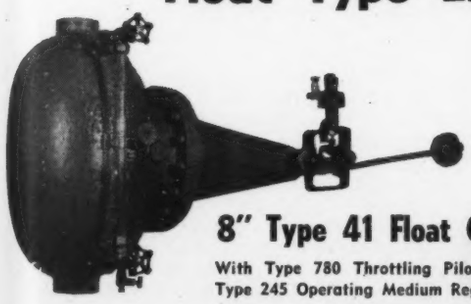

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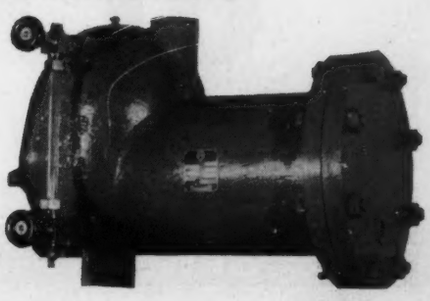

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**Petroleum Resins,** C. A. THOMAS, *Chem. Eng News* **20** (1942) pp. 1507-8.

A hard, amber-colored resin, melting about 100° C., is obtained on addition of aluminum chloride to the distillate resulting from high-temperature, low-pressure cracking of hydrocarbons of low molecular weight. The types of resins produced depend upon the proportion of diolefins, olefins and aromatic compounds in the distillate. Because of residual unsaturation the resins oxidize when exposed to the air in a thin film and are used in combination with drying or semi-drying oils for special purposes and in quick-drying varnishes. The properties of the resins can be varied by the use of other condensation and polymerization catalysts, such as sulfuric acid, boron difluoride or activated clays.

**Flow of Liquids Under Critical Conditions,** A. H. NISSAN, *Jour. Inst. Petr.* **28** (1942) pp. 257-73.

For Newtonian fluids the laws governing viscous flow through tubes of uniform cross-sections are well founded on both theoretical and experimental grounds. While not so well understood, the turbulent regime for these systems is fairly capable of determination provided certain implicit assumptions in the theory of dimensions are rigidly justified, particularly the principle of geometrical similarity. For the intermediate state existing between the two regimes, i.e., the critical state, there is still much in contradiction. Flow of fluids in the critical state was the subject of the author's investigation. The theory of the subject is first discussed, following which the apparatus is described, as well as the methods used in its operation. Two series of experiments were run, concentrating on the flow occurring between 2000 and 3000 Reynolds numbers. In laboratory experiments where special precautions are taken to eliminate all pulsations at the inlet to the system, a plot of log (f/2) vs. log ($R_e$) yields an asymmetrical S-shaped curve within the region of 1000-5000$R_e$. The limb of this curve, between 1000 and 2200 $R_e$, is not identical with the extrapolated curve of streamline flow. It lies above it. A plot of frictional head vs. rate of flow for these experiments yields two straight lines intersecting at an approximate value of 2400 $R_e$, and covering the region between 1000 and 5000 $R_e$. Above 5000 $R_e$ the plot is a curve characteristic of the turbulent region. There is no apparent unstable region connecting the two straight lines. The straight line covering the region 1000-2400 $R_e$ is identical with that obtained in experiments where pulsations were eliminated. In technical apparatus where

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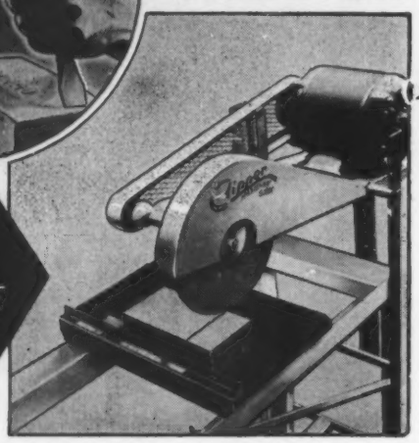

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pulsations are not eliminated the head lost in the critical region is proportional to the first power of the rate of flow, with the constant of proportionality assuming a value in the region 1000-2400 $R_e$ slightly greater than the value for the viscous regime, and assuming a still greater, but constant value, between 2400 and 5000 $R_e$. Thus the critical regime is similar to the viscous regime in having linear relationships between frictional head and rate of flow, and it is similar to turbulent flow in the small direct influence that viscosity appears to have.

**Selecting Construction Materials for Centrifugal Acid Pumps,** W. E. PRATT, *Chem. & Met. Eng.* **50** (1943) pp. 135-6.

One of the general problems in connection with all types of chemical pumps is the selection of a material suitable for withstanding corrosion and wear produced by the liquid or slurry to be handled, keeping in mind possible changes in process. The materials include: (1) stainless alloys of a wide variety in chrome-nickel and nickel-chrome, with smaller amounts of other elements; (2) nickel, and nickel-copper alloys; (3) copper-silicon alloys; (4) cast iron; (5) high-silicon iron; (6) rubber and rubber compositions; (7) carbon; (8) plastics; and (9) ceramics, including glass, stoneware and porcelain. One condition having an important bearing on the corrosion of an acid pump is the possibility of operation at shut-off (or with no flow). This is bad enough with water, but infinitely worse with acid. An ordinary centrifugal pump operating at 1750 r.p.m. with water in the pump and no flow passing through the pump, will cause the water to increase in temperature to the boiling point in 12 to 15 minutes. Since most acids increase in their corrosive properties toward metals with increase in temperature, it is easy to see what can happen to an acid pump when so operated. The question of electrolysis in connection with pump selections for different services is discussed.

**Transporting and Storing Liquefied Petroleum Gases,** P. M. RAIGORODSKY, *Chem. & Met. Eng.* **50** (1943) p. 134.

Competion will increase for tank cars for handling liquefied petroleum gases, isobutane, butadiene, isobutylene, etc., for synthetic rubber, aviation fuel, and other war materials. Ways and means for overcoming a shortage are discussed by the author. The number of tank cars available for the transportation of liquefied petroleum gas, butadiene, and butylenes as of August 1, 1942, was as follows: liquefied petroleum cars (104A) 1594; cars being built (Rubber Reserve Co.) 250; new cars (delivery started 1-1-43) 100; proposed conversion from 104 to 104A 150; total 2094. In addition to the number of cars, the time required for a complete round trip is of the greatest importance. Storage facilities must be expanded and arranged so that products can be quickly and safely stored in order to eliminate any delay whatsoever in the return of tank cars to active service. Closest cooperation between companies will be required in order to use existing equipment with a maximum of efficiency. The number of pressure tank cars available to the liquefied petroleum gas industry as such will decrease during 1943 because of the

# *Cooperating with Uncle Sam*

Four independent refiners joined together in 1931 to build the world's first cooperative Dubbs-cracking unit Its purpose was to crack the oils from their respective refineries to the best advantage of all Universal designed it It was enlarged in 1939

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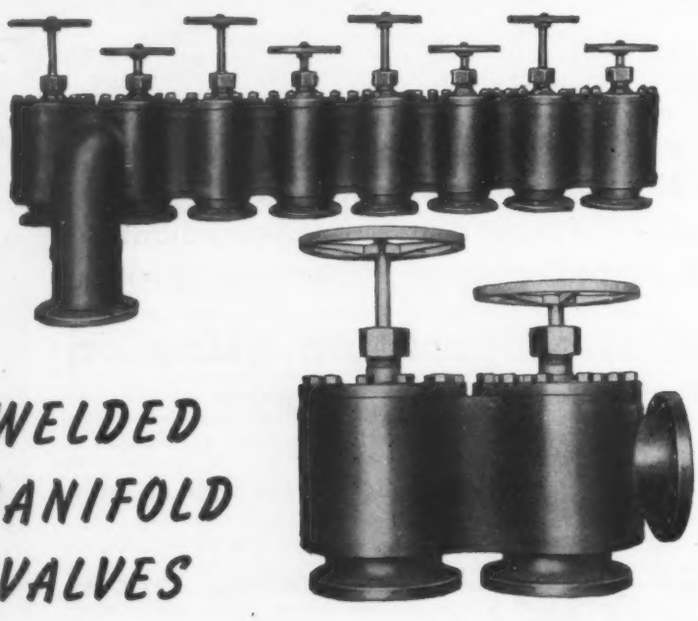

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need for cars for synthetic rubber and aviation gasoline plants.

**New System of Container Cleaning,** *Petroleum* **5** (1942) p. 157.

The Gasolvator is used for cleaning, degreasing and gas-freeing all types of containers such as vessels, tanks, barges, bunkers, oil-immersed transformers, pipe lines, drums, barrels and containers for conveyance and storage of such materials as heavy, light or lubricating oils, tar, bitumen and paint. Films and deposits within the containers are removed by solvent action. The Gasolvator is charged with solvent heated in the coils on the device by steam. The solvent vapor is discharged under pressure and at considerable velocity into the container. The deposits on the walls and seams are penetrated and saturated. The vapor condenses, and the contaminants are removed in solution, suspension or emulsion. The time required is short. The sludge is drawn as a solution, and can be filtered and the solvent recovered. The unit is self-contained except for the steam supply, and is simple and safe to operate. Air can be introduced finally to drive off the residual vapor of the solvent that remains in the container.

## Products: Properties And Utilization

**Lubricating Oil Detergency,** S. K. Talley and R. G. Larsen, *Ind. & Eng. Chem., Anal. Ed.* **15** (1943) pp. 91-5.

Detergency is a necessary property of lubricating oils for use in internal combustion engines. Specifically, oils must have the capacity for carrying away soot and other combustion chamber detritus, as well as their own decomposition products, in order that engine deposits shall not accumulate and interfere with normal engine operation. This requirement creates a special problem in Diesels, which produce relatively large amounts of soot from incomplete combustion of the fuel, and it has been found necessary to incorporate detergent additives in oils for such service in order to avoid premature engine failure from ring sticking. High-output engines that operate at high piston and cylinder wall temperatures also create special detergency problems in regard to lacquering and ring sticking. For low-output engines, operating on clean burning fuels, the inherent detergency of plain mineral oil is usually sufficient to keep the engine clean. While acceptable detergent additives have been on the market for a number of years, the development of newer and better additives has been hampered by the lack of simple laboratory methods of testing oils specifically for detergent properties. The significance of lubricating oil detergency is discussed with reference to various types of internal combustion engines. Four methods for evaluating this important property are described. One is a chromatographic procedure for determining the depth of penetration through sand of lampblack suspended in the oil. Two other methods involve separation of alphaltenes from the oil, by centrifuging and by filtration through an asbestos mat, respectively. The fourth depends upon the relation between the degree of dispersion of oil-soluble material and transmissivity to infra-red radiation. In the chromatographic test, lampblack was

# WASCO NEWS

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## W-S Line of Forged Steel Fittings Meets Wide Range of Needs

★ The complete line of Watson-Stillman Forged Steel Fittings includes Screw End Fittings and Socket Welding Fittings — 90° Elbows, Tees, 45° Elbows, Crosses, Street Elbows, Laterals, Couplings, Reducers, Bushings, Caps, Plugs, and Unions. These products are made from solid steel billets by manufacturing methods which insure uniform wall thickness, maximum wall strength and absolute concentricity. Bulletin A-3 describes and illustrates the complete line.

throughout the manufacturer's near-century of hydraulic experience. The line is described and illustrated in a recently - published Bulletin A-4.

## W-S Hydraulic Jack Line Features "Double Diamond" Quality

★ Among the first Watson - Stillman products to be manufactured as a standard item, hydraulic jacks now appear in a redesigned line offering the high quality always associated with the W-S "Double Diamond" Trade Mark. Included in this line are Independent Pump Hydraulic Jacks, Vertical Outside Pump Hydraulic Jacks, Horizontal Outside Pump Hydraulic Jacks. Bulletin 710-A gives information on this line.

## W-S Hand and Hydraulic Shears Cut Fast and Clean

★ The adaptability of the Watson-Stillman line of shears for fast, clean cutting of iron bars as well as wire rope and steel cable fits the wartime tempo of speeding up production. Only a change of blade is required to adapt W-S Hand or Hydraulic Wire Rope Shears for cutting flat bar iron or round iron. All parts of W-S Shears are interchangeable. Additional information is furnished in Bulletin 740-A.

## New Valves Recently Added to W-S Line

★ Specially designed for hydraulic service, Watson-Stillman high pressure valves are now supplied in several types never before furnished. Many former W-S Valves have been redesigned and engineering improvements introduced. Retained from previous models are features developed

## Complete Hand Pump Line Draws On W-S "Know-How"

★ Designed and built to operate jacks and other small hydraulic tools and machines, Watson-Stillman Hand Pumps are backed by an experience of 95 years in the manufacture of hydraulic equipment. This line includes Single Plunger and Double Plunger Hand Pumps and Pumps with large, medium or small tanks. Bulletin 240-A describes and illustrates W-S Hand Pumps, and is available on request.

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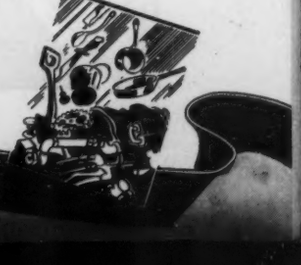

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selected because of its similarity to the sooty fuel deposits in Diesel engines, and the laboratory results are in good agreement with experience on the Caterpillar Diesel. On the other hand, the procedures employing asphaltenes measure the peptization of oil oxidation products and correlate more nearly with ratings of the Lauson and certain other engine tests. It is concluded that the laboratory tests are of interest in elucidating the nature of deposit formation in engines and, within limits, also provide a useful means for evaluating the detergent characteristics of lubricating oil additives. However, specific application of the tests requires consideration of the type of material deposited in a given engine as well as the operating temperature.

**Conservation of Lubricating Oil,** Oil Advisory Panel, Transvaal Chamber of Mines, *Jour. Inst. Petr.* **28** (1942) pp. 285-96.

The article is a report by the Oil Advisory Panel of the Transvaal Chamber of Mines. It concerns the precautions to be taken in storage and handling of lubricating oils in order to conserve them. It discusses the application of lubricating oils from the standpoint of conservation in such devices as feeders and in lubrication of air-compressor cylinders, locomotives and rock drills. Wick oilers and bottle oilers are considered. The lubrication of plane bearings, ball and roller bearings and open gears, is briefly discussed. Circulating systems are considered, including those for compressor crankcases, steam-engine crankcases, steam turbines, hoist hydraulic systems, gear-boxes, gyratory crushers, Diesel locomotives, motor transports, transformers and switchers, and the like. The reconditioning of lubricating oils is briefly considered. In an appendix to the article the consumption of lubricating oils and greases for various services is stated.

**Synthetic Rubber,** R. B. Barnes, U. Liddel and V. Z. Williams, *Ind. & Eng. Chem., Anal. Ed.* **15** (1943) pp. 83-90.

Infra-red spectroscopy offers methods for the identification, analysis, and control of hydrocarbon mixtures that have decided advantages over physico-chemical methods now in use. Ordinary chemical methods for the analysis of mixtures of hydrocarbons are long and tedious. Resort has been had to the method of physical separation of the components by fractional distillation, with identification of the components by their boiling points. This method is accurate, but time consuming. Therefore a method of analysis that requires at most a matter of minutes, and, in control, a matter of seconds, is highly desirable. The spectroscopic method works equally well with gases or liquids, and requires only a small fraction of the material needed for distillation. The infra-red spectrum of an organic compound is a unique property of that compound. Except in special instances it retains that property on admixture with other compounds. These special instances are predictable, and are of no interest in discussing simple hydrocarbons. Thus, in general, in any particular hydrocarbon mixture, the concentration of a given compound can be determined by infra-red measurements, if at least one absorption band

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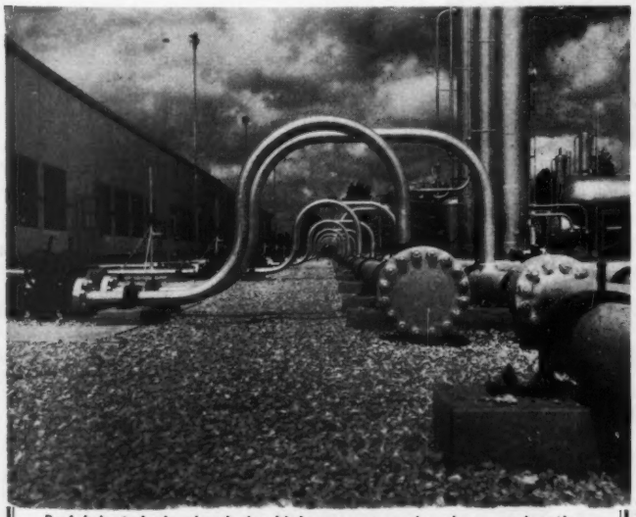

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of this component can be found at a wave length for which the remainder of the mixture has negligible absorption. A determination of the percent transmission at this wave length enables one to measure the amount of this component that is present. That the problem of spectrochemical analysis by infra-red is essentially simple can be seen by considering the various molecules of the components as mechanical systems. The origin of the infra-red spectra lies in the mechanical motions of the atoms of the molecules. It is the purpose of the paper to present the infra-red spectra of certain compounds of particular interest in the manufacture of synthetic rubber, and to describe a method for analysis and for production control. Spectra of several synthetic rubbers are also shown. An apparatus suitable for the making of such analyses is described. It does not require the services of skilled technicians. It can be easily converted into an automatic control device for the control of production. The spectra of the natural and synthetic rubbers illustrated provide information concerning the structure of the rubber molecules and could be used to identify the type of rubber present in unknown samples.

**Cryoscopic Analysis of Styrene, Indene and Dicyclopentadiene,** E. H. SMOKER AND P. E. BURCHFIELD, *Ind. & Eng. Chem., Anal. Ed.* **15** (1943) pp. 128-9.

Small quantities of certain impurities in monomeric styrene, indene, and dicyclopentadiene markedly affect the properties of polymers produced therefrom. Limitations of analytical methods for the detection of small quantities of impurities based on bromine absorption or on the accurate measurement of several physical properties are well known to investigators in this field. It was believed that an analytical procedure based on the depression of the freezing point of the hydrocarbon would provide a precise and sensitive method, dependent on the relative number of molecules of hydrocarbon impurities present and practically independent of the type of impurities. Data on the freezing point of styrene, indene, and dicyclopentadiene solutions are presented in tabular form. The data indicate a precise analytical method for the detection of small quantities of impurities in the hydrocarbon.

## *Helium Plant Facilities Being Widely Expanded*

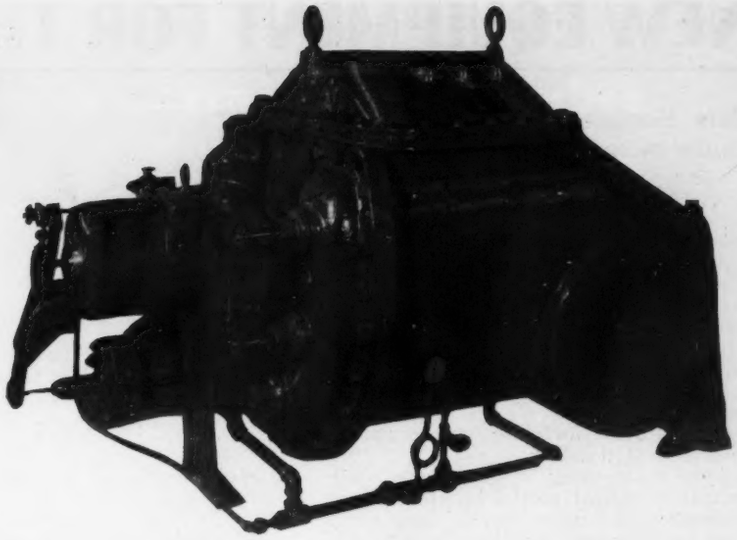
Aiming at an output this year some 40 times the pre-war production of helium, the Bureau of Mines has shipped the first carload of the gas from its new and largest helium plant "somewhere in Texas" and is rushing work on four other plants under a program involving the expenditure of $16,000,000.

All the new plants are located in the "southwestern area" and presumably away from the original plant at Amarillo, Texas, built in 1929, but recently expanded to increase production by 500 percent. The plant just brought in, however, will have an even greater capacity, two of the remaining four will have about the same and the other two about half the capacity of the Amarillo plant. All will work on a continuous schedule.

# MURRAY

## TYPE UV

## Multi-stage Mechanical Drive Turbine



**The "UV" Multi-stage Turbine parallels the design of the Type "U" Single Stage Turbine. It has the same unique and patented arrangement of the casing which is split horizontally well above the shaft centerline. This construction provides a longer steam ring with greater nozzle area and larger steam inlet size, larger exhaust opening, additional hand valves and improved efficiency.**

**View shows the unit equipped with mechanical shaft type main speed governor and hand speed changer. Also shown is the standard centerline exhaust end support and flexible steam end support.**

**The "UV" turbine can also be provided with oil relay governor—either of the constant or variable speed type; as well as extraction or extraction mixed pressure gear.**

**MURRAY IRON WORKS COMPANY, Burlington, Iowa**

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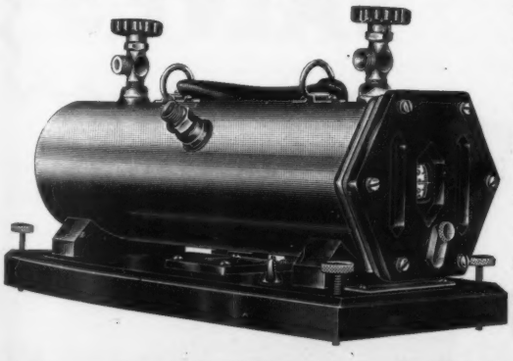

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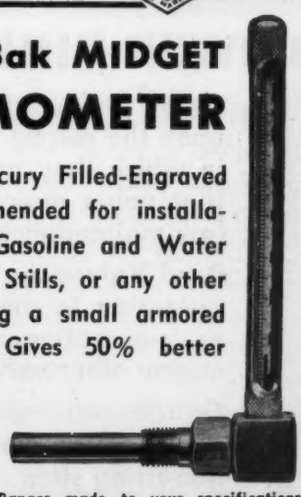

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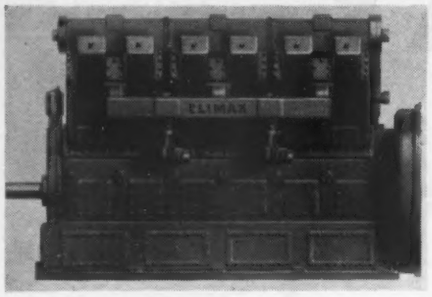
**CLIMAX ENGINEERING COMPANY**

Climax Engineering Company, Clinton, Iowa, announces the V-12 Blue Streak engine. The unit is designed to deliver peak power on natural gas, butane, gasoline and other like fuels. Change-over for any fuel is quickly and easily made with standardized, outside-located accessories. Dual carburetion provides uniform fuel distribution, aiding in obtaining full power output with low fuel consumption. Venturi-type carburetors, equipped with sensitive pilot valves, provide for close fuel regulation and prevent flooding.

Dual spark-plug systems are used, guarding against partial ignition failure through the cutting out of one plug. The combustion chamber is specially shaped to assure maximum turbulence as aid to proper combustion. The shape of the chamber and spark-plug locations are designed to reduce tendency to detonate when sudden or sustained overloads are encountered.

Large-capacity cooling jackets cover the entire length of stroke. This feature, combined with wide spacing of valves and entrance of cooling water where heat is greatest, is designed to insure cool running and consequent long life.

The engine is said to have been designed and manufactured to permit maintenance by regular field or shop men, without need for special training. The low piston speeds and moderate compression ratios are chosen with a view of permitting long runs without need for servicing.




Climax V-12

Climax V-12 is available in two bores. Model V-335, 6½-inch bore and 7-inch stroke, develops 375 horsepower at 1200 r.p.m.; while Model V-390, both bore and stroke 7-inch, develops 435 horsepower at that speed.

Dual ignition may be obtained in the following combinations: dual battery, dual magneto, or combined battery and magneto ignition. Standard design features include wet cylinder sleeves, seven-bearing crankshaft, overhead valves, aluminum (5-ring) pistons rifle-drilled connecting rod and fuel change-over devices. Where required, a complete range of accessory equipment such as starting devices, air cleaners, filters, radiators, heat exchangers, etc., may be selected to meet the specific needs of the particular installation.

## Vane Type Pump

**HYDRA-MOTIVE DIVISION**

Hydra-Motive Division, 723 East Milwaukee Avenue, Detroit, has three new constant-delivery, hydraulic-vane-type pumps, designed especially for high pressure. They are available in three sizes from 2½ to 60 gallons per minute.

The maximum continuous operating pressure of the standard pumps is 1250 pounds per square inch, but the pumps are also available for operation at considerably high pressures. Pressures as high as 2000 pounds per square inch can be handled by the pumps for prolonged periods without damage or overheating.

The use of dual vanes counterbalances the total outward pressure on the vanes and prevents overheating and wear even at excessively high pressures. Instead of a single vane in each vane slot, two vanes are used. Each of these is ground with a bevel so that oil under full operating pressure can reach the outward edge of each pair of vanes. This back or counter-balancing pressure can be varied by changing the angle at which the vanes are ground so that the vanes are held against the stator with only the necessary amount of pressure to effect an adequate seal.

Compound pumping consists essentially of employing the ends of the vanes nearest the shaft to function as a piston-type pump. On the intake cycle, when the vanes move outwardly from the center, they "pick up" oil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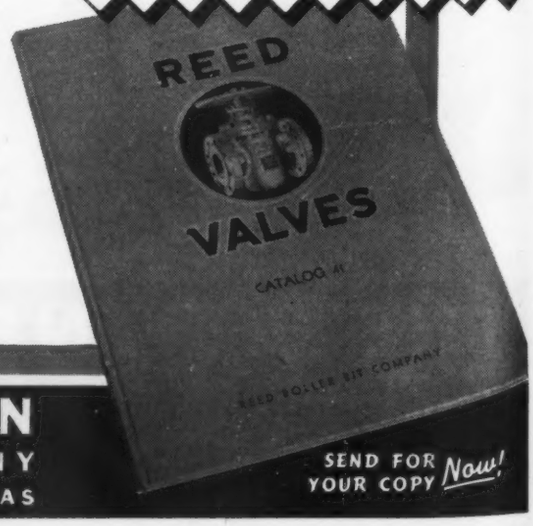


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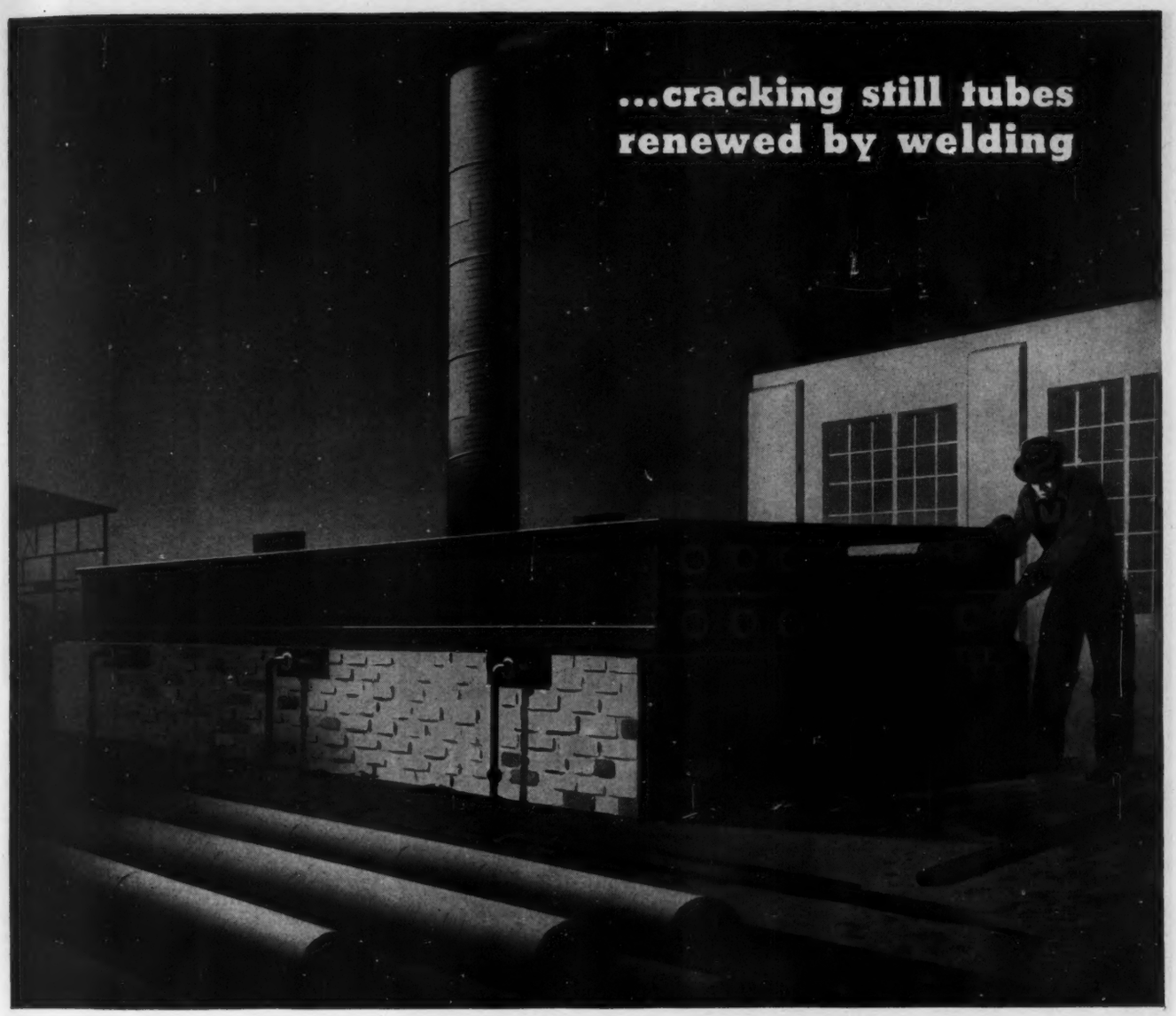


*Information supplied by "Petroleum Refiner"*

The present shortage in alloy steels has led refineries to develop a number of ingenious practices for the preservation and repair of existing equipment. One instance, that should be of general interest, concerns the repair of cracking still tubes.

It is characteristic of tubes to show excessive damage at the ends due to corrosion and erosion. Consequently, when furnaces are down for coke removal, tubes should be calipered. Those thin only at the ends can be segregated for renewal.

A simple renewal system consists of cutting off the damaged lengths, leaving beveled ends. Short lengths are cut from undamaged tubes of the same composition and diameter. The stubs are long enough to restore the tube to its original length, being cut with one beveled and one square end.

The stubs are butt welded to the tubes, and then the assembly is stress relieved. Many refineries have built their own heat treating furnaces for this purpose. It is recommended that data on the proper stress relieving treatment be obtained from the tube manufacturer and followed carefully in treating the welded tubes.

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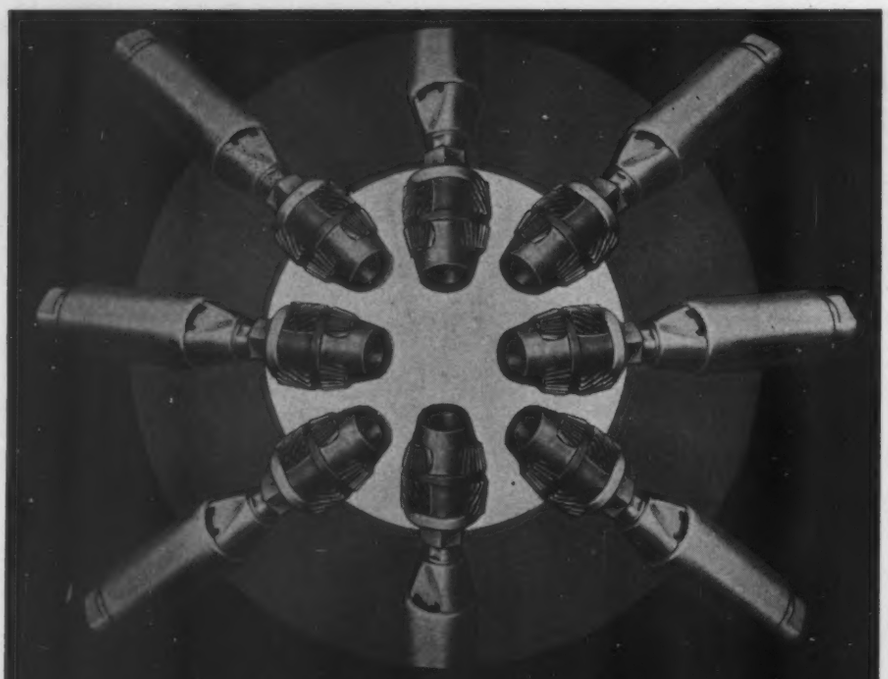

# *LESS* STILL "DOWN-TIME" MEANS *MORE* PRODUCTION!

You can materially *reduce* still tube cleaning down-time and *increase* the production of vitally important petroleum products by using Wilson "EP" (Extra Power) Tube Cleaners and the correct Wilson Cutter Head or other accessory for cleaning heavily coked still tubes quickly and thoroughly.

Wilson "EP" Tube Cleaners *reduce* down-time to the minimum and assure a marked increase in production because they have *extra speed, extra power* and *extra efficiency* designed and built into them. Used in conjunction with the correct Wilson Cutter Head or other accessory, they remove *quickly, thoroughly* and *economically* either soft, gummy, or exceedingly hard and heavy deposits from *any* refinery tube.

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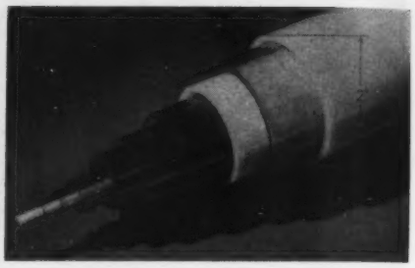
from an intake port and trap it in the vane slot. On the outlet or pressure portion of the cycle, when the vanes are forced back toward the shaft by the change in contour of the stator, the oil is forced out of the vane slot into an outlet port which connects with the main outlet. This sequence occurs twice during each revolution of the rotor and at diametrically opposite sides so that the operation is entirely balanced. Thus all forces on the shaft bearings are cancelled out.

## Plastic Tubing

**EXTRUDED PLASTICS, INCORPORATED**

Extruded Plastics, Incorporated, Norwalk, Connecticut, announced that seamless plastic tubing is now available in all diameters up to 2-inch O.D., and that the size will shortly include 2½-inch O.D.



**Plastic Tubing**

This new tubing is extruded from Tennessee Eastman cellulose acetate. It is being distributed throughout the country from Crane Company, Chicago, and Julius Blum & Company, New York City, warehouses.

## Explosion-Proof Motors

**FAIRBANKS, MORSE & COMPANY**

Fairbanks, Morse & Company, 600 S. Michigan Avenue, Chicago, announces a new line of vertical hollow-shaft ex-

**Fairbanks-Morse Motor**

# Designs for the Future

## will include All-Metal Thermometers

More and more, designers of tomorrow's products are incorporating WESTON *all-metal thermometers* in their specifications because of the many advantages these thermometers provide.

For critical temperature requirements, its *1% full scale accuracy,* and its ability to maintain that accuracy over longer periods, are most appealing. This *long-term* accuracy is made possible by WESTON'S simplified, all-metal thermometer construction. There is no gas nor liquids employed... no capillary... no involved mechanisms. Simply one moving part, and even that part is made of enduring metal. Thus it withstands vibration and over-ranging, and is self-protected against mechanical abuse. Moreover, it has an attractive, dial-type scale which can be read from a distance... *easily and accurately!*

What appeals to designers of *all* types of equipment and appliances, however, is the fact that the physical form of this thermometer lends itself so readily to problems of design. It can be designed *into* a product, rather than made an accessory thereto.

While sales of WESTON all-metal thermometers are at present limited to essential requirements, descriptive bulletin giving complete specifications will gladly be sent to design engineers on request. Weston Electrical Instrument Corporation, 655 Frelinghuysen Avenue, Newark, New Jersey.

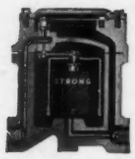
**WESTON *All-Metal* TEMPERATURE GAUGES**



PIPEWRENCH PETE SAYS:

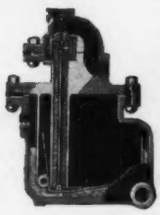
**THIS NEWS WENT TO THE FRONT OFFICE... AND NOW THEY CALL ME MISTER!**

Steam costs money. The "big shots" know it. And when their new battery of cookers uses 27% LESS, they want to know why. I'm still wonderin' why they gave me an office with my name on the door for tellin' them plain horse sense like this:



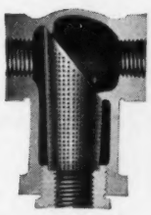
**1** STRONG 70-T TRAP for quick-heating cookers, etc. Lets out all the air. Shuts tight soon as steam hits it. Can't dribble because of the exclusive anti-balancing device. Packs as much quality as Strong's larger inverted bucket (80 series) trap. Guaranteed a year.

★



**2** STRONG 30 REGULAR TRAP for any drainage job, particularly separators, headers, engine manifolds. Install one and watch it work. You'll still be patting yourself on the back 10, 15 years from now, on account of the Anumetl valves and seats and wear-proof parts.

★



**3** STRONG, QUICK-CLEANING STRAINER. Makes reducing valves, traps, controls, etc., live longer and work better, by taking out scale, dirt, grit or sand. Just open the blow-off to clean it.

★

**4** STRONG REDUCING VALVES. Type K of complete line shown. Name your own reduced pressure from 85 pounds down, and this valve keeps right on giving it to you. ANUMETL valves and seats guaranteed for a year.

★

HOW DO **YOU** SIZE STEAM TRAPS? Easy method, plus valuable information on installations, etc. Send for Catalog 63-R-1.

**Strong Carlisle & Hammond Company**
**1392 West Third St., Cleveland, Ohio**

***Write for name of your nearest distributor***

**STRONG**
**STEAM SPECIALTIES**

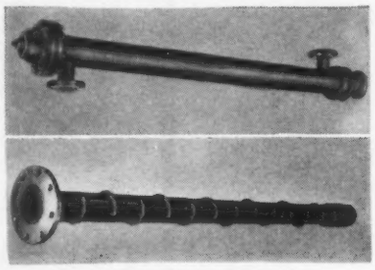
plosion-proof motors, developed for operation in Underwriters' Class I Group D hazardous gas locations. These motors are designed primarily for pumps handling large quantities of volatile materials. However, numerous applications are arising requiring motors that will prevent explosions and fires, and this new type is recommended to minimize such hazards.

## Heat Exchanger

**DOWNINGTOWN IRON WORKS**

Downingtown Iron Works, Downingtown, Pennsylvania, is offering a new standardized heat exchanger.

With only minor changes in its basic construction, such as baffle spacing and length combinations of units, the device can be used for many forms of heat exchange between two fluids in medium temperature ranges where temperature of one fluid materially exceds that of th other. It also adapts to cooling, heating, condensing and evaporating processes.



Downingtown Heat Exchanger

## Floor Cleaner

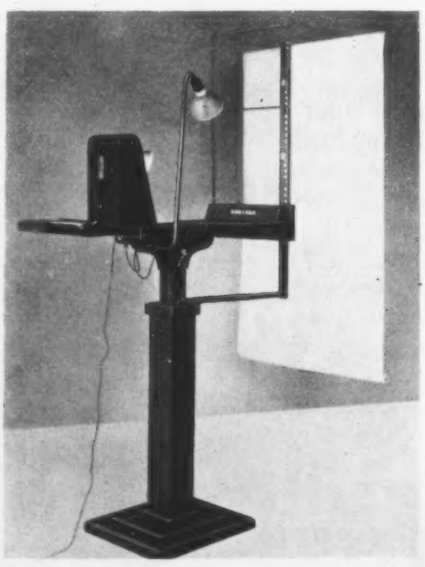
**LACEY-WEBBER COMPANY**

Lacey-Webber Company, Kalamazoo, Michigan, announces a new floor-cleaning compound designed for use in industrial plants. The compound is said to have a high degree of oil or grease absorption, as well as being fire resistant.

## Photographic Unit

**PHOTOGRAPHIC EQUIPMENT COMPANY**

Photographic Equipment Company, Park Way and Sandusky Street, Pittsburgh, Pennsylvania, announces a new photographic unit designed especially for industrial plants. Features of the



Photographic Unit

# SAIGON, INDO-CHINA

## *Half Way Around the World*

**Looking south across the China Sea toward Singapore stands the city of Saigon, Indo-China. There also, half way around the world, you will find Layne Wells and Pumps producing millions of gallons of water daily.**

**Layne Wells and Pumps are in operation in all parts of the world. Their skillful design, sturdy construction and amazingly long life features are known to engineers everywhere. Facing a world of the keenest competition, Layne Wells and Pumps have long been rated as the finest that skill and experience can build.**

**Primarily designed and built for peacetime work, Layne Wells and Pumps, under rigorous war-time overload conditions, are today making a magnificent record. Failures are almost unknown—a splendid tribute to the company's slogan of "Better Built for Better Service."**

**Production is now nearly 100 percent for the war effort, but every effort is being made to keep private and municipal installations in operation. For literature, address,**

**LAYNE & BOWLER, INC.**
**Memphis, Tenn.**

**LAYNE**
**PUMPS & WELL WATER SYSTEMS**

*Affiliated Companies*

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| Layne-Arkansas Company | Stuttgart, Ark. |
| Layne-Atlantic Company | Norfolk, Va. |
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| Layne-Central Company | Memphis, Tenn. |
| Layne-Northern Company | Mishawaka, Ind. |
| Layne-Louisiana Company | Lake Charles, La. |
| Louisiana Well Company | Monroe, La. |
| Layne-New York Company | New York City |
| Layne-Northwest Company | Milwaukee, Wis. |
| Layne-Ohio Company | Columbus, Ohio |
| Layne-Texas Company | Houston, Texas. |
| Layne-Western Company | Kansas City, Mo. |
| Layne-Western Co. of Minn. | Minneapolis, Minn. |
| International Water Supply, Ltd. | London, Ont. |

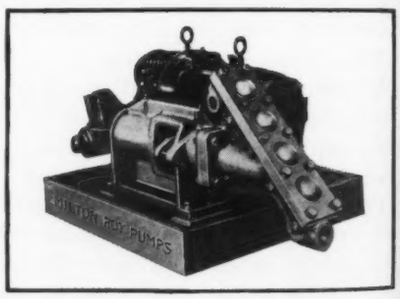
WORLD'S LARGEST WATER DEVELOPERS

This self-cleaning Milton Roy Step-Valve handles solids in suspension, slurries, sludges, and materials of heavy viscosity with little danger of clogging.

# This STEP-VALVE Makes Milton Roy Pumps "Tick"

Note how pumped materials pass through double-ball checks in four distinct steps. These checks act instantly. Each pair open and close practically simultaneously. They seat positively, not only when pumping clear liquids but also in handling slurries, etc. Should the liquid contain solids of sufficient size to prevent a ball from properly seating these would, of course, lodge in the first inlet check. The other checks continue to function as usual. Then the full pressure of the incoming liquid, on the following suction stroke, is exerted against the solid matter and clears the ball and seat. *All Step-Valves are of this same basic design.* Milton Roy Pumps are recommended for handling

**OILS • SLUDGES • ASPHALT**
**SOLVENTS • LATEX**
**PROCESSING CHEMICALS**



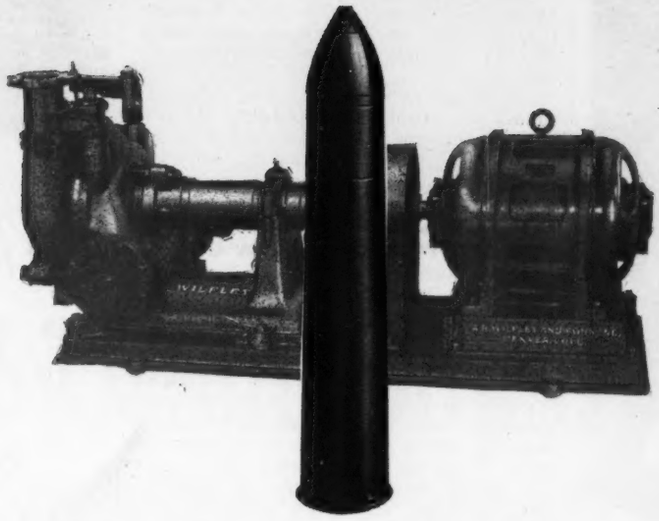
and other materials which are extremely difficult or impossible to pump by other means . . . as well as for acids, alkalis, intermediates, fluid greases, etc.

This Step-Valve (patented) is not only self-cleaning and non-clogging, but air-binding is impossible and wire-drawing is eliminated.

Investigate Milton Roy Pumps . . . for refinery services, for use where exact volume control is necessary, for hydrostatic test purposes and high pressure catalysis up to 20,000 lbs. per sq. in. Write for catalog.

*We are still making prompt deliveries of most standard units. If we can help in your war production write, 'phone or wire.*

**MILTON Roy PUMPS**
1383 E. MERMAID AVE., CHESTNUT HILL, PHILA., PA.



# THERE'S A PUMP.....
# BEHIND EVERY SHELL!

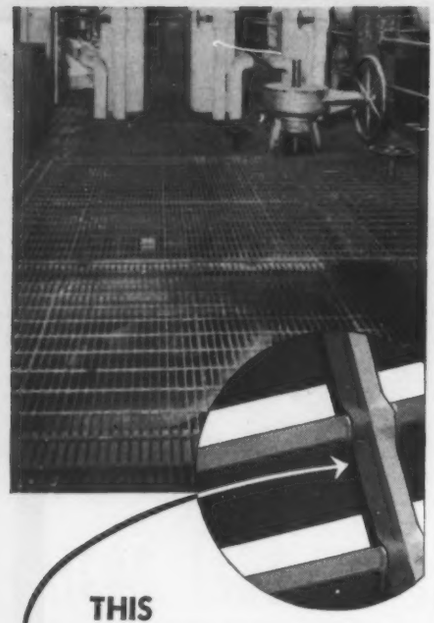
In that important stage of production between ores and ready-to-use alloys and metals, you'll always find WILFLEY pumps at work . . . delivering 24-hour-a-day performance day after day and month after month without attention. This is the HIGH EFFICIENCY pump that keeps sands and slurries moving 'round the clock. Exclusive features of design and construction, backed by years of experience in building DEPENDABILITY into every part make WILFLEY the pump to use in any battle for increased production. Heavy pumping parts of rubber, alloy iron, alloy steel . . . individually engineered to insure best results on your particular job.

*Write for Complete Details*

## A. R. WILFLEY & SONS, Inc.

**DENVER, COLORADO, U. S. A.**

**NEW YORK OFFICE: 1775 BROADWAY, NEW YORK CITY**



THIS
SCRAPER TREAD OF
**BATES-GRATES**
OPEN STEEL FLOORING
GIVES THE
**COMBINATION OF SAFETY AND CLEANLINESS**
YOU WANT IN OPEN STEEL FLOORING

This extra cleanliness and safety come with the use of welding technique that, for years, has been recognized as the correct method to follow—a simple fillet weld.

There is no burning and no overflow of surplus metal around the fillet into which is press-welded Bates Hex Bar Stock. You get top strength and rigidity in steel flooring that permits the maximum passage of air and light.

*Write for the new catalog "FILLET WELD BATES - GRATES" that gives complete details—well illustrated to show how advantages of this open steel flooring can be used in your plant.*

**WALTER BATES COMPANY, INC.**
1707 ROWELL AVENUE • JOLIET, ILLINOIS
OPEN STEEL FLOORING • STAIR TREADS


Model B WIM Identification Unit include a white washable background, self-levelling easel base, increased counter-weight capacity, finger-printing equipment, demountable light brackets for increased portability, elevator-can't-slip ratchet lock, and an accurate height indicator.

Designed to meet exacting requirements for proper photographic identification, the outfit can be operated by untrained operators. Capacity is better than 1000 pictures for an 8-hour day.

## Goggle Cleaning Compact

**MINE SAFETY APPLIANCES COMPANY**

Mine Safety Appliances Company, Braddock, Thomas and Meade Streets, Pittsburgh, announces a new goggle-cleaning station as an aid for workmen to keep goggles clean.

The station is designed for wall mounting and consists of a compact equipped with a lens-cleaning and anti-fogging agent and optical wiping tissues. A tap on the inverted vial sprays the liquid on the goggle or spetacle lens. Cleaning tissues can be pulled from the opening in the top of the container. The front panel slides up for refilling.

## Fume Exhauster

**CHELSEA FAN & BLOWER COMPANY**

Chelsea Fan & Blower Company, 1206 Grove Street, Irvington, New Jersey, has introduced a new and improved fume exhauster, a feature of which is said to be that fumes, gases, dust, filings and grinding compounds do not come in contact with the motor.

The centrifugal-type blower wheel is made of ⅛-inch steel. In order to meet all the rough usages to which the blower might be subjected, the three-horsepower motor is tested to an overload capacity. The framework is welded into a unit with handles for carrying. Interchangeable adapters make the outfit suitable for suction or blowing, as desired. The unit is adaptable for use in welding rooms, tunnels, vaults, basements, etc.

## Pipe Repair Clamp

**DRESSER MANUFACTURING COMPANY**

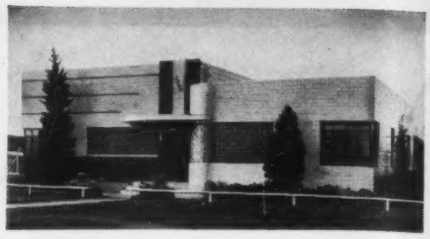
Dresser Manufacturing Company, 414 Fisher Avenue, Bradford, Pennsylvania, announces a new pipe-fitting repair clamp. This clamp, Style 77, is sprung open and slipped over any straight length of pipe in which there is a small leak. The ends are brought together, a bolt is inserted to hold the ends together, and a nut placed and tightened until the leak is stopped. A rubber gasket in the shape of a flat cone with positioning tabs on each side can be used with the clamp. Sizes of the clamp range from one to 26 inches outside diameter.

## Truck

**YALE & TOWNE MANUFACTURING COMPANY**

Yale & Towne Manufacturing Company, Philadelphia, Pennsylvania, has recently introduced a bantam sized Telescopic Lift Tilting Fork Truck for handling loads up to 2000 pounds.

The truck measures 98 inches by 30 inches from fork tip to stern. The single fork height lift of 71½ inches has additional telescopic lift to 129 inches. The outfit has four speeds forward and reverse. Controls are easily accessible, and hoisting and tilting controls are fitted with mechanical limit safety stops.

*New Complete*
**CATALOG**
***Now Available***

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**LYNCH REFINERY**
KILGORE, TEXAS

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**TULSA WAREHOUSE STOCKS**

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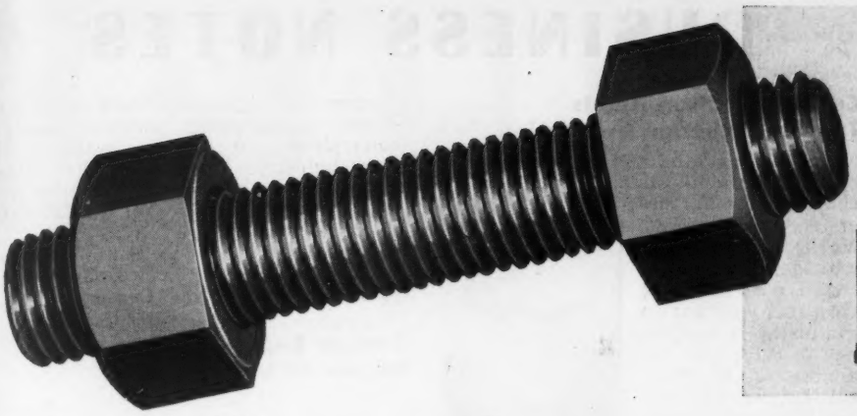
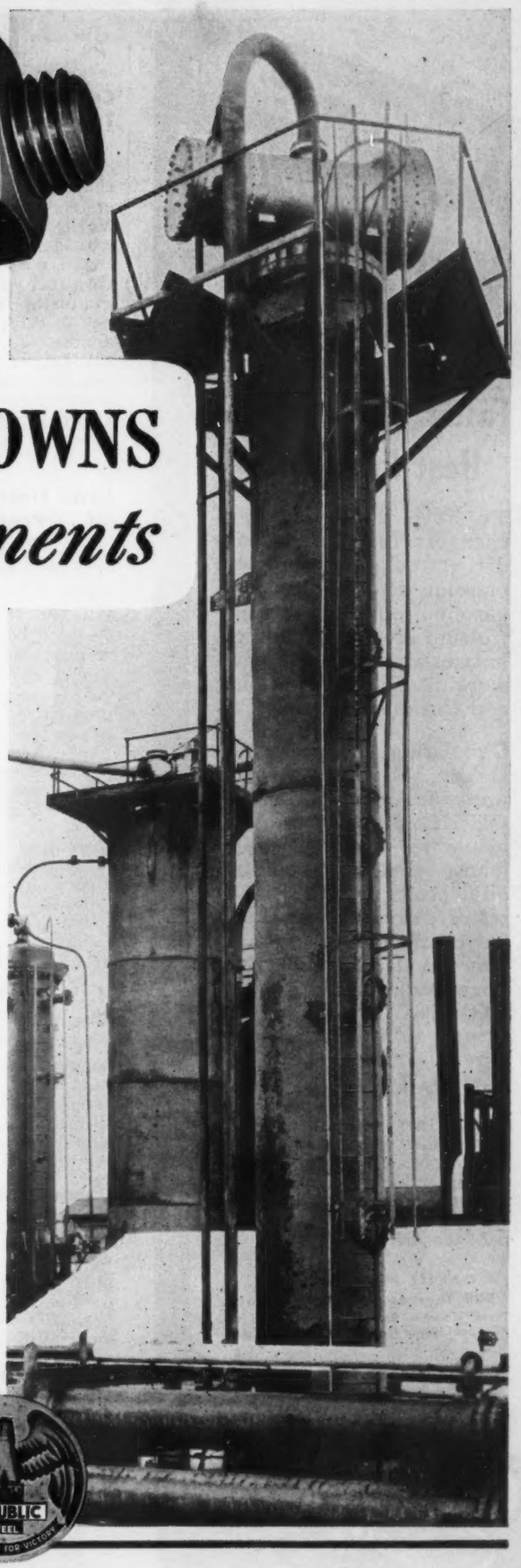
Completely reconditioned refinery equipment. Valves and Fittings—Storage Tanks. Wire, phone or write for your catalog now.

**SONKEN-GALAMBA SUPPLY COMPANY**
UNION AVE. AT 21st STREET
TULSA, OKLA.





# KEEP DOWN SHUTDOWNS *due to Stud Replacements*

## STEP UP WAR FUEL OUTPUT WITH REPUBLIC UPSON ALLOY STUDS

"Off stream" periods stem the flow of fighting power to our warships, bombers, tanks and jeeps and delay the day of Victory. So, guard critical high-pressure, high-temperature points against stud failures—with Republic Upson Alloy Studs.

With refining capacity going full-steam, full-time, you want studs that will stand up under longer periods of severe corrosion, extreme heat and pressure, heavy wrenching. That's why you need Republic Upson Quality.

Now, when so much is at stake, there's no time for costly and dangerous experiments with untried, inferior studs. Specify tested and proved Republic Alloy Stud Bolts.

**REPUBLIC STEEL CORPORATION**
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Niles Steel Products Division • Steel and Tubes Division
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# REPUBLIC

# *Upson Quality* BOLTS AND NUTS

**Other Republic products include Electric Weld Casing, Tubing and Line Pipe—Electrunite Heat Exchanger Tubes**

YOUR ANSWER for speeding wartime MAINTENANCE

Faster Way to Clean Heat Exchangers

To help keep heat exchangers in efficient condition to meet today's pressing demands for more gasoline, oil and other petroleum products, many refineries are using safe, fast-working Oakite de-scaling and cleaning materials.

Circulating the prescribed Oakite solutions through units as directed THOROUGHLY removes ALL insulating lime-scale and many types of carbonized oil deposits . . . QUICKLY restores normal heat transfer efficiency! The job is done in HALF the time often required with other methods . . . units are returned to service sooner!

NEW Manual FREE!

For further data on reducing down-time in de-scaling and cleaning your coolers, condensers, interchangers, preheaters, and other heat exchangers, write for NEW, 24-page manual. It's FREE!

OAKITE PRODUCTS, INC.
50B Thames Street, New York
Technical Service Representatives Located in All Principal Cities of the United States and Canada

OAKITE Specialized CLEANING

Buy Bonds for Victory

# ☆ BUSINESS NOTES ☆

## Cuyler S. Patton Heads Tubular Exchange Association

Cuyler S. Patton has recently been elected president of the Tubular Exchanger Manufacturers Association, New York. He is salesmanager for American Locomotive Company. Patton graduated from Cornell in 1918, with the degree of Mechanical Engineer, and has been with American Locomotive Company since that time.

C. S. Patton

## Lowe Elected President Of %Proportioneers%

Rudy P. Lowe has been elected president of %Proportioneers%, Inc., Providence, Rhode Island. He has been associated with the company since 1932, as vice president and chief engineer. Since graduating from Illinois Institute of Technology in 1922, he has been active in the field of engineering, having served in Chicago as consulting engineer in the building industry for 8 years, following his graduation. Then for a short time before joining %Proportioneers%, Inc., he was consulting engineer in the water works field.

R. P. Lowe

## H. K. Porter Company Opens Philadelphia Office

H. K. Porter Company, Pittsburgh, announces opening of a district office for Eastern Pennsylvania, Western New Jersey, Maryland and Delaware, in the Girard Trust Building, Philadelphia. Roy B. Rose has been named manager for the territory.

## Durametallic Corporation Advances R. R. Smith

Roscoe R. Smith has been advanced to the position of salesmanager and chief of field engineers for Durametallic Corporation, Kalamazoo, Michigan. He has been associated with Durametallic since 1928, as sales representative.

## H. B. Zachry Company Has New Office Building

H. B. Zachry Company, general contractors, recently completed a new modern office building in San Antonio for the use of its executives and engineers. The company is engaged in turn-key construction of refining plants, gasoline plants, cycling plants, pressure maintenance plants and pipe lines in the petroleum industry. Recently it has been engaged in air base construction for the Army, one project being of the $20,000,000 class.

Headquarters in San Antonio is on Harding Boulevard. Offices are maintained in Houston and Laredo.

Zachry's San Antonio Office

## Gauger Representing Harper at Los Angeles

Clarence A. Gauger has been placed in charge of the recently opened Los Angeles office of H. M. Harper Company. Gauger was formerly associated with Pacific Metals Company, in Los Angeles.

## New Rubber Plant Opens In Havana, Cuba

Opening of a new rubber plant in Puentes Grandes, a suburb of Havana, Cuba, was announced recently by The B. F. Goodrich Company. Present output of the establishment will be truck and bus tires and tubes, and tire-repair materials, including camel-back.

Crude rubber to be used was on hand in Cuban warehouses before December 7, 1941, and no further stocks will be required this year. The project was begun in 1940, but halted temporarily by the war. Total cost of the plant was approximately $1,000,000. It will operate under the name of Compania Gomera Goodrich Cubana, S.A., and will employ 200 people.

## Edwards Valve Company Awarded Maritime Pennant

Edwards Valve & Manufacturing Company, East Chicago, has been awarded the United States Maritime Commission's Maritime "M" pennant, Victory Fleet flag and Labor Merit badges, in recognition of the "unfailing ability of the company to meet contracts with the Maritime Commission on schedule or ahead of schedule."

## Bristol Names Akron Manager

George R. Atkins has been appointed manager of the branch at Akron, Ohio, by The Bristol Company, Waterbury, Connecticut. He has been with the organization since 1929, the year following his graduation as a Chemical engineer from Northeastern University.

In 1935 he went to the Pittsburgh district sales engineering staff and a year later was made resident sales engineer at Greenville, South Carolina. He returned to the Pittsburgh office a short time before going to the post of manager at Akron.

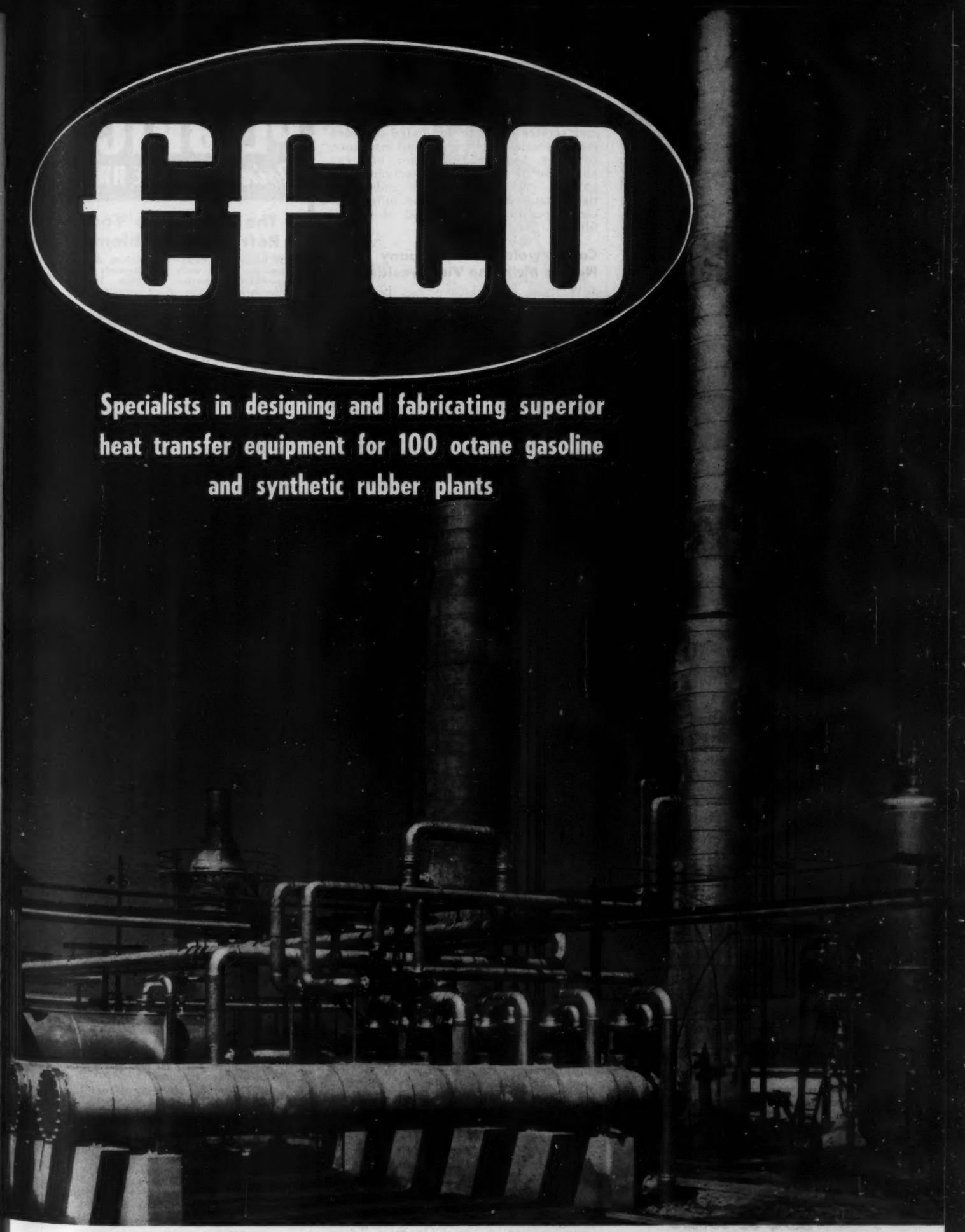
## Microstat Corporation Enlarges Service

Microstat Corporation, Norwalk, Connecticut, announces extension of its service to Canada and Mexico, with opening of offices in Toronto, and Mexico City.

Reorganization of the company has also been effected, with Eliot Hyman in charge of licensees and sales engineering, and M. S. Lehman in charge

# EFCO

Specialists in designing and fabricating superior heat transfer equipment for 100 octane gasoline and synthetic rubber plants



## ENGINEERS & FABRICATORS, INC.

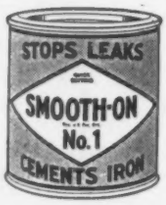
P. O. BOX 7395 — EFCO — HOUSTON, TEXAS

**This crack, between the air starting valve port and the cylinder head water jacket of a Diesel engine, seemed impossible to repair.**

**However, the ingenious engineer simply fitted a pipe sleeve into the port, filled the crack with SMOOTH-ON No. 1, also applying a thin coat of SMOOTH-ON No. 3 to cement the sleeve in place. The repair was speedily made and has proved entirely satisfactory.**

**When you are up against a crack or break in a machine casting, or a leak at a joint of any kind, or a loose part of fixture, think first of SMOOTH-ON. This many-purpose iron repair cement, used by plant engineers and maintenance men for 47 years, will frequently enable you to make repairs quicker and at less cost than by any other method.**

*Buy SMOOTH-ON in 7-oz., 1-lb., or larger containers from your supply house, or if necessary from us. For your protection, insist on SMOOTH-ON, used by engineers and repair men for over 45 years.*



**FREE**

**REPAIR HANDBOOK SHOWS HOW**

**40 Pages, 170 diagrams, and simple concise instructions for practical repairs to plant equipment, pipe lines and structures. A necessity in every plant. Your copy sent FREE if you fill in and return the coupon.**

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*Do it with*

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of all financial and insurance functions.

The program of licensee and customer service being promulgated includes not only sales engineering and insurance coverage, but the elaboration and exploitation of all necessary technical apparatus, cameras, formulae and practices that will result in the most efficient operations in the field of microfilming.

### Copperweld Steel Company Names McIlvane Vice President

William J. McIlvane has been appointed vice president in charge of sales and assistant to the president, of Copperweld Steel Company. He formerly was general manager of sales.

### Socony-Paint Products Receives Merit Awards

Socony Paint Products, a division of the Socony-Vacuum Oil Company, and the men and women of its Long Island City plant, have received the Maritime "M"" Award, the Victory Fleet Flag, and the Maritime Merit Burgee, for production excellent and special achievement in the war program. The ceremonies were held at the plant.

### McFate to Manage Tubular Sales

J. E. McFate has been appointed manager of tubular sales for the Republic Supply Company, Houston.

Until this change he was with the pipe division of Republic Steel Corporation at Tulsa.

### Cooper-Bessemer Doubles Volume in 1942

A business volume twice as great in 1942 as compared with 1941 was shown by Cooper-Bessemer Corporation in its annual statement recently released. A net profit of $820,000 was realized after deduction of taxes and a $1,100,000 reserve for post-war adjustments and other contingencies.

### Monsanto Chemical Company Announces Promotions

Monsanto Chemical Company, St. Louis, Missouri, announces that Charles Belknap has been made president, and that Edgar Monsanto Queeny, former president, has been elevated to chairman of the board of directors. In addition to his duties as president, Belknap will continue as chairman of the executive committee, and as chairman of the board, Queeny will continue to devote all his business efforts in behalf of the company.

Both men have been associated with Monsanto Chemical Company for a number of years, Belknap since 1929, and Queeny since 1920.

Kelknap was president of Merrimac Chemical Company which was purchased by Monsanto in 1929, after which time he became vice president of Monsanto and also a member of the board of directors. He graduated from the United States Naval Academy in 1903 as ensign, and rose to the rank of commander before his resignation from the Navy in 1919. During World War I, he was director of Naval Overseas Transportation Service, reporting to the Chief of Naval Operations. Under his direction 550 troop carriers, cargo carriers and convoy vessels transported all the


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*Jointless* **FIRE BRICK**

**The Answer to Your Refractory Problems!**

**FOR boilers and stills—for patching and repairs—for entire walls and complete relining—Plibrico Jointless Firebrick is the dollar-saving, trouble-saving refractory that refineries everywhere are adopting.**

**Plibrico forms a solid, monolithic lining that eliminates the weak joints of laid-up fire brick construction. Flexo-Anchors prevent bulging. No special shapes are required; Plibrico comes in moist, plastic form and can be readily moulded to any shape. Your own maintenance men can install it or we furnish complete installation service.**

**For extreme conditions, there is the Plibrico sectionally-supported air-cooled wall. And the Plibrico suspended arch for boiler arches and still roofs. Both are erected without special tile or heavy castings.**

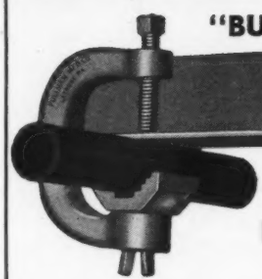
**These catalogs cover your requirements.**

**Here is the complete story of Plibrico linings, arches, air cooling, etc. Ask for your Plibrico catalog. Specify whether operating H.R.T. or water tube boilers.**

**PLIBRICO JOINTLESS FIREBRICK CO.**
**1803 Kingsbury St., Chicago, Illinois**

**Latrobe PRODUCTS**

★FLOOR BOXES ★ WIRING SPECIALTIES★



**"BULL DOG" PIPE OR CONDUIT HANGERS**

**Convenient and adaptable for a wide range of work in refineries, mills, and factories.**

**Made of high quality malleable iron. Electro plated with cup point case hardened set screw, it holds with bull dog tenacity.**

**Saddle turns freely for pipe to run parallel to beam or at angles.**

**No. 470 to hang pipe ½", ¾" and 1" to beams ⅜" thick.**

**No. 471 for pipe 1¼" to 1½".**

**"BULL DOG" INSULATOR SUPPORTS**

**Ideal for fastening porcelain and glass insulators to exposed steel framework — Made of malleable iron.**

***Jobbers' inquiries invited. Price list and complete information upon request.***

**FULLMAN MANUFACTURING CO.**
**LATROBE . . . PENNSYLVANIA**

*"I've got to get this back to Dow"*

## YES! IT'S URGENT—HANDLE DRUMS CAREFULLY—RETURN PROMPTLY

We know you are fully aware of the urgent need for drums and other chemical containers. But again we call to your attention these important points:

- Drums now in circulation *are all there are! Make them last!*
- Handle drums carefully—*don't drop or mishandle.*
- Keep drums under cover—*store in dry places.*
- Replace plugs carefully—*don't strip threads.*
- Keep drums clean—*don't use for other materials.*
- Empty or half-filled drums standing in warehouses, yards or shipping platforms serve only the enemy.
- *So Send Them Back to Dow Today!*

**THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN**

New York • St. Louis • Chicago • Houston • San Francisco • Los Angeles • Seattle

DOW

CHEMICALS INDISPENSABLE TO INDUSTRY AND VICTORY

men and materiel of the American Expeditionary Forces of 1917 and 1918. For his services in this work he was awarded distinguished service medals by both the Army and the Navy.

Queeny was educated at Cornell and entered the Monsanto organization as advertising manager in 1920. He later was in the export sales department, and in 1924 was made sales manager, and shortly thereafter vice president, and then president, in 1933.

## Board Chairman of Allis-Chalmers Dies

Max W. Babb, chairman of the board of Allis-Chalmers Manufacturing Company, Milwaukee, died March 13 following an illness of several weeks.

He had been connected with the concern since 1904, when he became its attorney. He became its vice president and general attorney in 1913. In 1932 he was elected president, a position he held until January, 1942, when he was elected chairman of the board.

His other business connections included that of director of Cutler-Hammer, director of the Federal Reserve Bank for the Seventh District and a member of the executive committee of the Northwestern Mutual Life Insurance Company.

## Vice President of Dresser Company Dies

Merrill N. Davis, executive vice president and secretary of Dresser Manufacturing Company, Bradford, Pennsylvania, died March 7. He had been associated with the company since 1919, when he took charge of sales and advertising.

He was a native of Millbridge, Maine, and had his public school education in that state. When 15 years old he went to Boston and began his business career. Shortly he was connected with the rubber industry and in 1916 organized Rexhide Rubber Manufacturing Company, serving two years as its vice president and sales manager. After two years he returned to B. F. Goodrich Company.

In August, 1919, Davis became associated with Dresser Manufacturing Company, in charge of sales and advertising. In December, 1928, he was elected a director and on January 3, 1929, was made vice president of the company and in May, 1932, was given the additional title of secretary.

Davis had been actively identified with the Association of Gas Appliances & Equipment Manufacturers since it was organized in 1935. He served as vice president of that organization in 1935-36 and the following year was elected president.

He was a member of the American Gas Association, Pennsylvania Gas Association, New Jersey Gas Association, Pacific Coast Gas Association, Canadian Gas Association, Oil and Natural Gas Men's Association of Canada, American Petroleum Institute, West Virginia Oil & Gas Men's Association and Ohio Oil & Gas Men's Association.

## Steel Box Cars Move Oil in Large Quantity

Seen by ODT officials as a promising new development which may help deal with the oil-transportation problem, the B and O Railroad has reconstructed a standard automobile-type steel box car to carry a load of 12,200 gallons of oil, considerably more than the average tank car handles.

Four steel tanks encased in wooden boxes were fitted into the car, which has had trial runs, moving fuel oil from Baltimore to Washington.

If further tests prove the advantages of the experiment and the necessary material can be obtained, it was said, ODT may recommend the conversion of several thousand cars, figuring that each thousand cars could add more than 15,000 barrels to daily rail deliveries.


**REFINERY MAINTENANCE ENGINEER**

Man thoroughly familiar with machine shop practice, as well as all types of refinery mechanical equipment, including pumps, compressors, turbines, motors, boiler house equipment, etc. A graduate engineer who has served a machinist's or mechanic's apprenticeship is preferred. Position is of supervisory nature in engineering or maintenance department of middle size refinery in the Middle West. In reply, state draft status and salary required, as well as a complete outline of education and experience. Box 555, c/o Petroleum Refiner, Houston, Texas.

**WANTED**
**ASPHALT TECHNOLOGIST**

Position requires man with technical degree who has had five years experience in the manufacture and blending of roofing and paving asphalts. Location, middle West with medium sized oil company. Our employees know of this advertisement.

Box 450, c/o Petroleum Refiner
Houston, Texas

FOR SALE—Two 250 hp. boilers, two-stage air compressor, 75 kw. a.c. generator, ammonia condensers, receivers, pumps, hoists, motors absorbers, generators, valves and fittings. 10" Taylor recording thermometer, Taylor anemometer and sling psychrometer. Must dismantle at once. Capital Ice Refrigerating Co., Indianapolis, Ind.

WANTED — Position as stillman. Have 25 years experience operating Dubbs Cracking Units, Stabilizers, Topping and Asphalt Plants. Available about April 15th and can go anywhere. Excellent References. Box 303, c/o Petroleum Refiner, Houston, Texas.

**High Pressure Power Pumps**

2½—4 x 6 Stroke.
Pressure—1000 p.s.i. working.
2000 p.s.i. hydrostatic.
Double suction and shaft extension.
Roller bearings—herringbone gears.
Interchangeable liners.
Trim to suit pumping conditions.

*Also manufacturers of these type pumps:*

SIMPLEX and DUPLEX
STEAM and
POWER DRIVEN
HORIZONTAL and
VERTICAL
FORGED STEEL, CAST STEEL
BRONZE and Various
ALLOYS
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MISCELLANEOUS DESIGNS

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QUICK REPAIRS ON
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HEAT EXCHANGERS

If you need condenser or heat exchanger repairs **in a hurry** call us. We specialize in fast, high quality work.

**25 Years Successful Experience**

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"Service, Not Promises"
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*A Complete Line of*
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INSTRUMENTS FOR INDICATING RECORDING AND CONTROLLING TEMPERATURE PRESSURE FLOW AND LIQUID LEVEL
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